Railway Age and Railway Engineering and Maintenance

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Contents

The Convention a Marked Success

THE thirtieth annual convention of the American Railway Engineering Association came to a close on Thursday afternoon after one of the most successful three days' session in the history of the association, from all the standards by which success is measured. The attendance, both by registration and by the numbers in the convention hall, was the largest on record, while the listeners were rewarded by hearing some of the most carefully prepared reports that have been presented for the consideration of the association. The results of former work, together with that spirit of co-operation between committees which is one of the accepted principles of the association, and the earnest effort of the committee members themselves, were evidenced by the matter presented in the reports. The discussion, while not as extended as could be desired in some cases, was constructive and gave evidence that the membership had taken pains to familiarize itself with the reports as published in the bulletins. With the example of the 1929 convention before it, the association may face the future with confidence.

The Highway Bridge Specification

THE most comprehensive feature of the report presented by the Committee on Iron and Steel Structures is the specification for steel highway bridges, which represents the work of a conference committee composed of representatives of Committee 15 of the A. R. E. A. and of the American Association of State Highway Officials. Circumstances attending the work of the bridge engineer in the employ of public highway authorities naturally differ widely from those to which railway structural engineers are accustomed. Therefore, it is to be expected that the personnel of the conference committee embraced rather divergent points of view, but in spite of this the deliberations of this body were conducted with a spirit of harmony that was effective in the drafting of a document that each of the participating groups has endorsed enthusiastically to the parent organization. There is every assurance, therefore, that substantially all of the clauses it embodies represent the result of a sincere effort to obtain the most satisfactory and workable conclusion, rather than a compromise drawn to meet the fixed opinions or prejudices of one party or the other. The A. R. E. A. representatives are to be commended for their part in this important work.

A.R.E.A. Committee Work

THE A. R. E. A. has long been conspicuous among associations in the railway field and elsewhere for the amount and high quality of its committee work. Since the inception of the organization primary emphasis has been placed on committee work. As a result it is not only unusually well organized and efficiently conducted, but the interest has been maintained throughout the 30 years of the association's life. All of these men serve voluntarily and on their own time so far as compensation from the association is concerned. The result is reflected in the amount and volume of reports presented. In this respect the A. R. E. A. is unique among technical associations.

Such a record has not resulted from accident. Rather it is a natural outgrowth of the foundation on which the association was first built. In its earliest years the founders saw the possibilities of committee work and planned the association along the lines on which it has since continued. At every step this committee work is fostered. As an illustration, on Thursday evening immediately following the adjournment of the convention the chairmen of the Board of Direction's committees on Outline of Work and on Personnal of Committees met with the chairmen and vice-chairmen of all of the committees to discuss the work of each committee in turn and to correlate the relations of one committee with another, in that way giving the heads of each committee an idea of the work of the association as a whole. Throughout the year, the secretary and the board's representative check the committees to insure that they are

working and to the proper objectives. All committees are required to have their reports completed and in the hands of the secretary by November 1, to enable him to have these reports printed and distributed sufficiently in advance of the convention to permit the members to study them carefully. At the convention practically the entire meeting is given over to the consideration of the work of the committees to the almost entire exclusion of individual addresses and papers, while the entire personnel of each committee is invited to the platform to participate in the presentation of its report. In short, every means is taken to stimulate committee work. The results justify this practice.

Motor Car Standardization

IS it practical to standardize many of the parts and accessories for track motor cars? This is a problem which has been confronting the Committee on Economics of Railway Labor ever since it was instructed to submit such standards three or four years ago. Opinion has been divided. Among the manufacturers are some who have advocated wide-spread standardization as a means of relief from demands from customers for special designs to comply with individual ideas as to how a car should be built and equipped. There have also been those who have been opposed to standardization as impractical and hampering development unless *their* car is accepted as the standard. Among railway men there are equally divergent opinions. Some prefer to buy cars from the manufacturer complete as he builds them, while others, confronted with the necessity of operating and maintaining cars bought from different concerns, desire to bring them to as nearly common standards as possible to simplify maintenance and reduce repair stocks. Confronted with this conflict of opinion, the committee has endeavored to find some common ground of agreement from which it could start. After several ineffectual attempts, it has made some progress this year, which encouraged it in the belief that further progress is possible. The committee deserves the co-operation of the manufacturers in order that the interests of the railways may be promoted by the standardization of those details of car construction of common concern, such as axle diameters for given types of cars, wheels, couplers, etc., and also to prevent encroachment on the field of such technical problems as engine design in a way that would limit the inventive genius of the manufacturer.

"Short Cuts" Have a Place

THE difficulty of attempting to develop formulas for use in studies of line and grade revision is well illustrated in that part of the report of the Committee on Economics of Railway Location and in the printed discussion by two members of the sub-committees which accompanied that report. While both discussions were based on objections to some of the methods used by the committee, both the report and the discussions constitute serious efforts to provide reasonably reliable values for obtaining comparisons of different projected lines, and are well worthy of study by all who are called upon to prepare such data.

It is, perhaps, not too much to say that no short cut can be evolved which will give correct results in all cases, since the traffic requirements vary so greatly on different roads, and even on different parts of the same road, that the adjustment of the variables would nullify the saving in time which the formula would otherwise effect. As was pointed out in one of the discussions, "short-cut methods must be used in many and probably in most cases, but they are rough approximations and may not safely be assumed to give correct results. The short-cut method here proposed has been most carefully worked out as to details and has the advantage of great simplicity. It will no doubt prove useful in many cases where great accuracy is not required and time is not available for more careful analysis."

Keeping in mind the thought that short-cut methods must necessarily be "rough approximations," the report together with the accompanying dissenting discussions, will do much to facilitate the final drafting of a formula which will be accurate enough for approximations to demonstrate whether more detailed studies are worth while, for the combination of a conscientious report and constructive criticism leads to the solution of the problem.

What Price Heavy Rail?

IN its report on the economic value of different weights of rail, the Committee on Rail has made a valuable contribution to the broad economics of maintenance as well and, while the report was necessarily presented for information only, it shows that the studies are along lines which should eventuate in reasonably accurate results and permit the use of a formula whereby the selection of the weight of rail for given traffic requirements may be made with some approach to accuracy, rather than by more or less inspired hopes or guesses.

It is, of course, recognized that, in the preparation of such formulas, the variables which enter into the computations are not susceptible of absolute determination, but they can be evaluated closely enough to form an excellent guide to the weight of rail which should be used to carry, with safety and economy, the traffic it will be called upon to bear. It will be appreciated, in view of the variables referred to, that a weight selected by this process should include a factor, not necessarily of "safety" but rather of "contingencies," aside from that included to care for the probable growth of traffic and axle loads of motive power. It has been a common experience that a weight of rail selected for a certain district has proved to be too light before it has reached the end of its service life where it was installed.

The report is of value in calling attention to the fact that the studies made indicate that an increase of weight from 70 lb. per yd. to 136 lb. per yd. will increase "U," the modulus of elasticity of the rail support, by 47½ per cent, and will decrease the stress in the rail and the pressure on the roadbed by 58 per cent and 62 per cent, respectively, while it probably will effect an improvement of 50 per cent in the track as a whole, with no changes in other parts of the track structure. This in itself is valuable information, if only to corroborate what previously has been arrived at by guess, but the committee has gone farther and has shown the results to be gained by increasing the depth of ballast, along with the rail.

The committee's study as to the cost of installing and maintaining track with different weights of rail for various traffic densities, unfortunately, is incomplete, but indicates that information of value can be obtained along the line adopted. Here the values of the variables are more vague, and this vagueness is increased when the results obtained on one road are compared with those from another. Undoubtedly, a number of such studies would present figures which should be of value on this subject.

CONVENTIONALITIES

W. S. Miller, manager of railroad sales of the Northwest Engineering Company, with headquarters at Chicago, was kept from the convention this year by illness. He is now in a hospital at Toronto, where he was taken ill while on a business trip.

C. A. Wilson, consulting engineer of Cincinnati, who by the way is enrolled as charter member No. 9 in the records of the association, bears the distinction of never having missed a convention. Mr. Wilson is now associated with the new union passenger terminal at Cincinnati, work on which is now in its early stages.

Word reached Chicago yesterday of the death in Del Monte, Cal., on March 6, of T. F. Merseles, recently elected president of Johns-Manville Corporation, New York. Mr. Merseles' death was due to heart disease. He had planned to leave Del Monte yesterday for his home in Bronxville, N. Y.

Past President Honored

J. L. Campbell, chief engineer, Northwestern Pacific, and a past president of the A. R. E. A., was the recipient of a tribute at the close of the convention in the form of a bronze medallion which was presented to him on the occasion of his retirement after six years service on the Board of Direction following his presidency and as a token of the association's appreciation of his long and active participation in its affairs. The face of the medallion carries the words "Past President" and stamped in relief are four figures with an appropriate allegorical significance, while the back of the medallion is inscribed with the following: "To J. L. Campbell, Contributor to the Science of Railway Engineering."

Front and Back Views of the Medallion

J. B. Cox bears the unusual distinction of having served on the Committee on Arrangements for every dinner that the association has held, this year's being the thirtieth. The length of Mr. Cox's membership is indicated further by the fact that he is number 23 on the records of the association.

For those who are interested in statistics, it might be mentioned that the delegates in attendance last year came from 42 states, the District of Columbia, and from six Canadian provinces. The states not represented were: Arizona, Nevada, New Hampshire, New Mexico, Rhode Island and South Carolina. In addition, members were present from Japan, Formosa, Manchuria, Scotland and India.

M. A. Zook, president of the Montana, Wyoming & Southern, was a member of the American Short Line Railroad Association party that held its annual convention in Mexico City and then toured the eastern half of Mexico as guests of the Mexican government and the National Railways of Mexico. While there he acquired considerable fluency in the pronunciation of such unpronounceable names as Popocatepetl and Xochimilco.

A Framed Fortune

On the wall in the office of President Barrett of Roberts & Schaefer Company, is a perfectly legitimate note for $400,000, neatly framed. There is only one slight flaw in its negotiability, and that is, that it is cancelled. The note was issued to the Continental & Commercial bank of Chicago and was signed by 22 University of Illinois alumni and was issued in advance of the collection campaign for the stadium, in order that construction might be begun before the last of the money was raised. The 22 signers guaranteed payment and, when the money was duly collected, framed copies of the bond were presented to each of the signers, of whom Mr. Barrett was one, by George Huff, director of athletics at the U. of Ill.

Gavel to Yager

Incident to the election of Louis Yager, assistant chief engineer, Northern Pacific, as president of the A. R. E. A., and in the course of his induction to that position at the close of the convention yesterday afternoon, the retiring president, W. D. Faucette, chief engineer, Seaboard Air Line, presented him with a gavel, made especially for the occasion. The material is of dark cedar with stripes of light yellow mock orange. The gavel is inscribed with Mr. Yager's name and becomes the possession of the president for use at the next convention and is a lasting token of the association's recognition of the leadership bestowed in him.

Among those attending the convention is Elmer A. Sperry, distinguished scientist. Mr. Sperry is now president of the American Society of Mechanical Engineers and chairman of the National Research Council. His latest scientific achievement is the development of the transverse fissure detector, two of which, mounted in cars, have been in service on various railways since last November.

One member of the Board of Direction of the A. R. E. A. who did not attend the convention this year was W. J. Backes, chief engineer, Boston & Maine, who sailed late in January for a rather extended trip abroad. E. B. Temple, chief engineer of the Eastern region of the Pennsylvania is another A. R. E. A. European traveler, having spent several weeks in Europe last summer. In fact the list of members of the association who are touring foreign countries is growing so rapidly that by another year we will probably have to confine mention to those members who make this trip in a rowboat or in a solo flight.

The Secretary's Hobby

Have you ever met Francis Joseph Fritch, aged 2½? If you have, you will understand why Secretary Fritch has only one hobby, namely, his grandson. Incidentally,

A Happy Trio

Mr. Fritch is making his first foreign tour next fall, when he goes to Japan as the official representative of the A. R. E. A. at the World Engineering Congress.

A Convert

It requires no argument to convince A. F. Blaess, chief engineer of the Illinois Central, that transverse fissures are a reality, for while traveling north from Memphis, Tenn., in his car last Spring, the car was derailed and turned over by a rail which was broken from this cause. While Mr. Blaess received no injuries other than bruises, it required some time to dig his secretary out from under an accumulation of files, typewriters and other equipment of a business car. Incidentally, Mr. Blaess was involved in a second wreck a few weeks later when his car was attached to the southbound train that ran into a pipe and was derailed near Mounds, Ill.

W. W. Glosser who was for several years a member of the P. & M. organization, later sales manager of the Verona Tool Works and more recently New York district sales manager of Hubbard & Co., has been transferred to Oakland, Cal., where he is in charge of production and sales for the latter company. "Wallie" took up his new duties early in February and reports indicate that he already aspires to become a "native son."

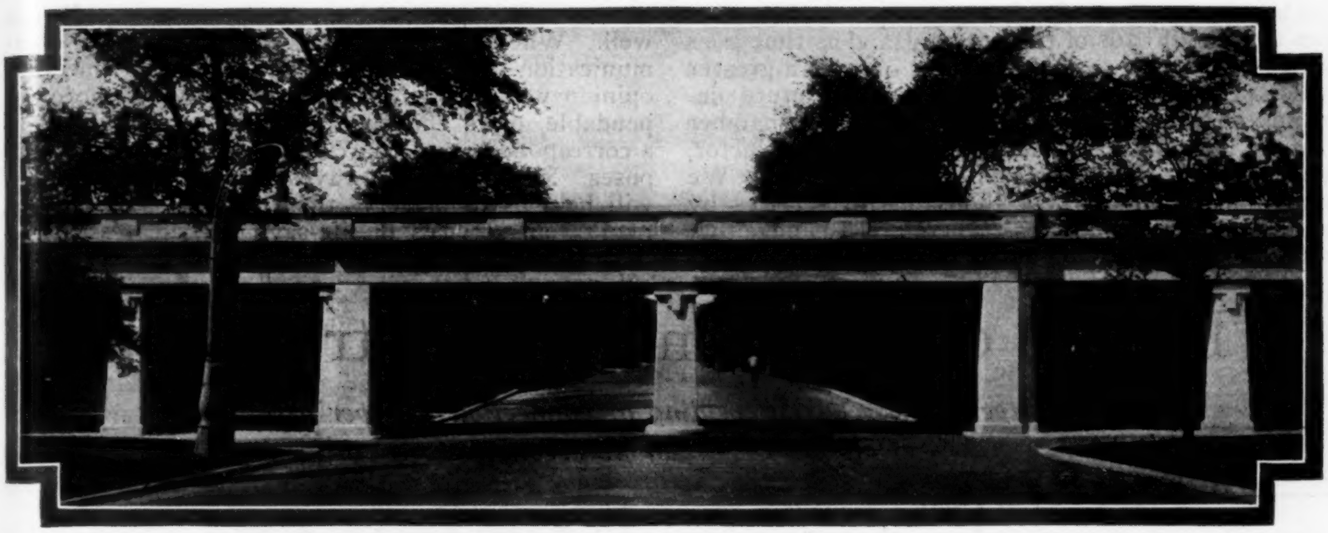
George Nichol, vice-president of the Johns-Manville Company, Inc., has just returned from two months on the Pacific Coast where he has been engaged in the reorganization and consolidation of the Celite Products Company with the Johns-Manville Company, Inc., following the purchase of the former organization in December. This company has also taken over the Banner Rock Products Company, Indianapolis, Ind., and the products of both of these companies were included in the exhibit of the Johns-Manville Company at the Coliseum.

What Chief Engineers Are Made Of

There's a children's verse that tells what little girls and boys are made of. As we recall it, little girls are made of "sugar and spice and all things nice," while the terrible constituents of little boys are just nobody's business. An ardent suffragette must have written the verse. In any event, inspired by the verse, an investigation was made of the histories of the chief engineers of 37 large railways to determine what they are made of and how they got that way. The results are interesting.

The average age of chief engineers is 57, the youngest of those checked being 44 and the oldest 72. In the main, they are small town boys, all but six of them having been born in towns of 10,000 or less. The Middle West and the East have a monopoly on the production of chief engineers, four each having been born in Kansas and Ohio and three each in Massachusetts and Pennsylvania. Two of the lot were foreign-born, one in New Brunswick and the other in Dublin, Ireland. All but seven are college graduates, Kansas University easily leading the list with five chief engineers as alumni. Tufts College, Yale University, Rensselaer Polytechnic, University of Maine and the University of Michigan can each claim two graduates in the ranks, while no other school has more than one.

No less than 16 of them began railway service as rodmen, others began as chainmen, draftsmen, track apprentices, etc. Only two entered railway service in other than engineering capacities, one as a clerk in the traffic department, the other as a machinist apprentice. Eight of them were promoted to chief engineers from the position of engineer maintenance of way, seven from assistant chief engineers and four from principal assistant engineers. Five were appointed chief engineers from positions in other departments, two having been superintendents and one each assistant to president, and chief clerk to president. One man was appointed chief engineer of a large road from the position of general manager of a small road. Fifteen are now chief engineers of the railway with which they began service, while only three were appointed directly from other railways. Only nine have ever done anything but railroading, although five have worked in Mexico and one in Haiti. Six of them are trying to live down the fact that they were once division superintendents.



Chicago, Milwaukee, St. Paul & Pacific Viaduct over Humboldt Boulevard, Chicago

A. R. E. A. Closes Convention

Address on radio in railroading included as part of yesterday's program

THANKS to the skill of President Faucette and Vice-Presidents Yager and Brooke as presiding officers, the convention program was carried out on schedule during the first two days of the convention, thereby simplifying the problem for the two remaining sessions yesterday. In addition to the reports of nine committees, the program included a brief talk by John Johnson of the Chicago World's Fair Speakers' Bureau and an address on radio and its application on railroads, by O. H. Caldwell, who until last week was a member of the Federal Radio Commission, and is now the editor of Radio Retailing. Mr. Caldwell explained the work of the radio commission in assigning wave lengths for various purposes. An abstract of his further remarks follows.

Abstract of Mr. Caldwell's Remarks

Already radio contributes to the operation of the modern American railroad in many ways. For example, radio telephone communication is today being operated experimentally between caboose and locomotive on long freight trains. At either end of the train, a member of the train crew can pick up a transmitter, talk into it and his voice will be heard with loud-speaker volume at the far end, a mile away, above all the noise of the train.

Similarly, radio telephony is being used at gravity switching yards for communicating between switch towers and locomotives. In this way time is saved, costs are reduced, and the safety of the men is increased. The possibility of keeping in continuous communication with freight trains from towers along the right-of-way is another development that is already in sight. The Federal Radio Commision has set aside five of the valuable short wave length channels for the use of transmitters operated by railroads, either on railroad rolling stock or on railroad tug boats in harbors. The railroad channels are designated as 2,410, 2,422, 2,440, 2,450 and 2,470 kilocycles.

Radio also presents possibilities for the greater convenience and comfort of the passengers. In Germany and Austria, for instance, passengers on fast trains between Berlin and Hamburg can maintain telephone conversations with their offices or homes in either city while they speed along at 60 m.p.h. Yet here in America, with our lavish scale of expenditure on traveling comfort, we are told that such telephone service would not pay. On some of the fast Canadian trains and on certain trains in the United States, each chair in the club car is equipped with head sets for listening to broadcasting.

Consider the dreary isolation of the average railroad waiting room, which might well be equipped with a loud speaker operated not by radio but over the telegraph lines of the railroad without disturbing in any way the message traffic on those wires. This would be wired broadcasting, not wireless. The railroad would be able to control its own program, and along with musical features, could interpolate valuable public-relations messages, information for shippers and the public. In this way any railroad could build up at small cost and a little effort of a few men, a chain of some hundreds or thousands of outlets which would render great service to its neighbors and patrons. Already the new owners of one railroad in Illinois have used radio broadcasting to educate the farmers along the line, thus improving their production and prosperity, and so increasing and stabilizing the traffic.

Broadcasting stations themselves have been employed for dispatching trains during emergencies, such as great sleet storms and other general wire interruptions. The 600 broadcasting stations which are now licensed, although only 160 can operate simultaneously, provide a great network available for emergency communication when all other means fail.

Therefore, radio is rendering many valuable services to the railroads of this country, and as time goes on, I believe, it is destined to serve on even a greater scale. But as you railroad men make future demands on radio service, I beg of you to remember that we have only this one great common conductor, which you can think of as a vast copper table. We must impose all of these thousands of services by using different frequencies. Therefore, I believe that your guiding policy should be to require no service of the radio where wires can perform equally as well. Where a wire circuit can be used for communication purposes, I believe that engineering opinion will show that the wire is always more dependable, more efficient and more economical than a corresponding radio circuit for communication purposes. Since our radio waves are so few, I hope you will help us to preserve them for the essential humanitarian services of life-saving, both at sea and in the air, where only radio can do the job.

Report on Iron and Steel Structures

Committee studies electric welding of connections, copper bearing steel, and results of numerous tests

A. R. Wilson
Chairman

THE committee presented reports covering the following subjects:

(2) Specifications for steel highway bridges (Appendix A).

(3) Feasibility of electric welding of connections in steel structures (Appendix B).

(7) Uses of copper-bearing steel for structural purposes (Appendix C).

(8) Effect of dead load on impact from moving loads on bridges (Appendix D).

(9) Rolling tests of plates (Appendix E).

(10) Punched and reamed work (Appendix F).

It recommended that the report in Appendix A be approved and inserted in the Manual, and that Appendices B, C, D, E and F be received as information. No revisions in the Manual were suggested but the committee reported that investigations and tests on a number of subjects are under way.

Appendix A—Specifications for Steel Highway Bridges

Under this subject the committee presented specifications for steel highway bridges, which it stated were compiled by a conference committee composed of representatives from the American Association of State Highway Officials and the A. R. E. A.

In scope these specifications are limited to the field of ordinary highway bridges and do not provide for unusual span lengths and types of construction for which provision must be made by special supplemental specifications. Owing to the extent of the specifications, which covered 59 pages in the bulletin, no attempt is made to reproduce any part of the specifications here, other than to give in the following a list of the subjects covered in each section.

Contents of Specifications

I—General requirements and basis of payment.
II—Materials.
III—Workmanship.
IV—Mill and shop inspection.
V—Full-size tests of eye-bars.
VI—Shop painting.
VII—Weighing, marking and shipping.
VIII—Erection.
IX—Field painting.
X—General features of design.
XI—Loads.
XII—Distribution of loads.
XIII—Unit stresses.
XIV—Proportioning of parts.
XV—General details of design.
XVI—Floor system.
XVII—Bracing.
XVIII—Plate girders.
XIX—Trusses.
XX—Viaducts.

Appendix B—Electric Welding of Connections in Steel Structures

The A.R.E.A. specifications for steel railway bridges do not permit the use of welding for bridge work nevertheless, welding is used very extensively for light structural work, tanks, reinforcement in old structures, etc. A number of fairly good size buildings have been completely fabricated and welded in the field.

In the early part of 1927, the Chicago Great Western's bridge over the Missouri river, at Leavenworth, Kan., was reinforced by means of electric welding and is giving very satisfactory service. The first all-welded through truss railroad bridge to be put in service in this country was built by the Westinghouse Electric & Manufacturing Co. over a power canal at Chicopee Falls, Mass. This bridge is a single track, single span structure of the Warren truss type, with sub-divided panels, and owing to the angle of crossing of the power canal, has a 72-degree skew. The length of each truss is 134 ft. 8 in., but owing to the skew of the bridge, its over-all length is about 175 ft. The width of the bridge between trusses is 17 ft., and the vertical height between the chords of each truss is 24 ft. 8 in.

Up to the present time, the art of welding has not advanced sufficiently to warrant its use in the fabrication of structural steel for railway bridges. For those desiring to use electric welding as a means of strengthening steel structures, it might be of interest to see the journal of the American Welding Society of April, 1928, which gives results of tests made by the Rensselaer Polytechnic Institute for the General Electric Company. It will be noted for specimens in tension the 3/8 in. by 3/8 in. triangular fillets of varying lengths gave an average longitudinal shearing strength of 13,300 lb. per lin. in. of fillet; whereas, compression specimens with varying lengths of 3/8 in. by 3/8 in. fillets gave from 17,800 to 15,800 lb. ultimate shearing strength per linear inch of fillet. It would seem reasonable that 3,000 lb. per lin. in. in design would give ample security.

Appendix C—Copper Bearing Steel for Structural Purposes

Information collected indicates the increased use of copper bearing steel for various industrial and structural purposes; it is now being used in the manufacture of steel cars, tie plates, track spikes, smokestacks, stationary boilers, metal culvert pipes, metal flashings, ventilators, wire fencing, light structural steel for warehouses, steel sash, power line supports, flood light towers, and overhead electrification structures for railway tracks.

Copper bearing steel in such service has, in many instances,

been found to last one and one-half times as long as ordinary steel. Service tests on copper bearing steel used in the manufacture of tie plates, over a period of five years, show: Copper treated steel—2 per cent loss in weight; non-copper treated steel—7 per cent loss in weight; and wrought iron—7 per cent loss in weight.

Similar tests on copper treated steel, for tie plates, over a period of 11 years, show: Copper treated steel—5 per cent loss in weight, and non-copper treated steel—20 per cent loss in weight.

Tests on cut spikes, over a period of six years, indicate the following: Copper treated steel—9 per cent loss in weight, and non-copper treated steel—15 per cent loss in weight.

After outlining tests on steel freight cars, 200 of which were manufactured and placed in service in 1914, one-half of each car being manufactured from copper bearing steel, and the other half from plain steel, the committee gave the following summary of the results of the tests:

(1) Paint adheres very much better to copper bearing steel in a car body than it does to plain open hearth steel.

(2) The saving in repainting cars, due to better adherence of paint to copper bearing steel, would be sufficient to justify the use of copper bearing steel in the bodies of steel freight cars.

(3) Where mechanical abrasion has not been a serious factor, as in the side sheets of gondolas, the loss in thickness for the copper bearing steel was only one-third as great as for the plain open hearth steel.

(4) Where the steel was subjected to severe mechanical abrasion as well as corrosion, the loss in thickness for the copper bearing steel was approximately 60 per cent as great as for the plain open hearth steel.

(5) From the results of this investigation it can be conservatively stated that the use of copper bearing steel in the body of the cars would increase the life of the car body from 33 1/3 to 50 per cent.

Other atmospheric tests on uncoated steel sheets, over a period of seven years, in a steel manufacturing district where smoke and gases prevail in the atmosphere, indicate that:

For No. 16 gage sheets ($\frac{1}{16}$ in. thick), 80 per cent of all non-copper bearing sheets failed in 75 months, while none of the copper bearing sheets failed within the same period.

For No. 22 gage sheets ($\frac{1}{32}$ in. thick), non-copper bearing sheet failed within 23 months—average life of copper bearing sheets 49 months.

Information collected shows that the use of copper bearing steel for structural purposes is widening, and its use is now extending to roof trusses in railway enginehouses and shop buildings that are exposed to marked corrosive influences, to foot bridges over railway yards, and in some instances, to turntables.

Copper bearing steel can readily be secured at a slight increased cost, orders for copper bearing steel are promptly filled, and the manufacturers indicate a spirit of co-operation in its introduction for structural purposes.

Appendix D—Effect of Dead Load on Impact from Moving Loads on Bridges

The report presented by the committee under this assignment comprised a treatise on the effect of dead load on impact, prepared by F. E. Turneaure, dean, college of engineering, U. of Wis. The theoretical calculations of the paper were built up around the formula, which appeared in the proceeding of the association for 1927, page 776,

$$I = K \frac{G\ r}{(w + p)\ cd}.$$

in which I=impact
K = some constant.
G = total weight of overbalance at crank pin center.
r = radius of crank pin circle.
w = dead load per foot.
p = live load per foot.
c = circumference of driver.
d = deflection of truss due to live load.

It was pointed out, that according to a previous analysis of this formula, the impact percentage is proportional to the quantity $\frac{G\ r}{c}$, which is a function of the locomotive, and inversely proportional to the total load and to the deflection. The effect of span length is taken into account in the items $(w+p)$ and d, both of these increasing with span length. The critical speed is less the greater the values of $(w+p)$ and d.

Under the discussion with respect to the theoretical effect of dead load and deflection, the paper continued as follows:

Assuming the locomotive factor $\frac{G\ r}{c}$ to be constant the impact will be $I = \frac{K}{(w + p)\ d}$.

(a) If w and p remain constant, but one truss is shallower than the other, its deflection will be greater and the impact less. This is due primarily to the slower rate of vibration, and hence lower critical speed.

(b) The effect of an increased live load p on the same structure is to lessen the percentage of impact, both by increasing p and increasing d. If the locomotive factor $\frac{G\ r}{c}$ is increased proportionately to p, then the decrease in impact will be much less, but there will be some. This general effect of an increased live load is well to bear in mind in using impact data secured by the use of light trains. The impact *percentages* so obtained will most likely be *larger* than those obtained by heavier or maximum loads. This principle is reassuring when considering the effect of an overload.

(c) Given two structures one heavier than the other, but so proportioned that the live load deflection is the same for both. The value of w is alone increased. The impact will then be less for the heavier structure. If $w = \frac{1}{2}p$ in the lighter structure and the heavier one is 10 per cent heavier, then the impact will be 33 1/3 per cent less in the latter structure.

(d) Given two structures of the same length and general

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W. L. Wilson, prof. of ry. engr., Lehigh U., Bethlehem, Pa.
W. M. Wilson, research prof. of str. engr., U. of Ill., Urbana, Ill.

*Died January 20, 1929.

dimensions and designed for the same live load and impact. Under these conditions the deflection of the two structures for dead load, full load and impact will be the same, being a function of general dimensions and working stresses.

Following further computations, it was pointed out that it appears that the impact does not increase proportionately with $\frac{G\,r}{c}$, but at a less rate.

Appendix E—Rolling Tests of Plates

Committee on the Bearing Value of Large Rollers has co-operated with the University of Illinois in making extensive rolling tests during the past year. These tests were made upon plates of solid rectangular sections similar to the sole plates used on the segmental girders and track girders of bascule bridges. The plates varied in thickness from one-fourth inch to four inches and the cylinders under which they were rolled varied in diameter from 116 in. to 476 in. Tests were made upon steel castings of medium grade when annealed and when hardened with heat treatment, upon steel of structural grade when annealed and when hardened by heat treatment, and upon an alloy steel sold under the trade name of Hylastic.

These tests were financed in part by the American Railway Engineering Association and in part by the Scherzer Rolling Bascule Bridge Company. The American Railway Association has appropriated $1,000 for the continuation of the tests another year.

Following a complete technical report of the tests made during the school year 1927-1928, the committee gave the following summary of the results of the tests:

(1) When a loaded cylinder rolls over a plate the deformation of the plate is influenced by the motion as well as by the pressure.

(2) The plastic flow under a rolling cylinder is materially different in character from the elastic deformation under the same cylinder at rest, the former being opposite in sense from the latter for some important deformations.

(3) Within the scope of these tests, the load required to produce longitudinal flow increased with the thickness of plate. There were indications, however, that an increase in thickness of plate beyond four inches might not be accompanied by a further increase in the load required to produce longitudinal flow. Likewise, there were indications that a decrease in the thickness of plate below 0.25 in. might be accompanied by an increase in the load required to produce longitudinal flow.

(4) The load required to produce lateral flow increased with the thickness of plate for thin plates but decreased as the thickness increased, for thick ones. The thickness of plate that had the greatest capacity to resist lateral flow was greater for large cylinders than for small ones, being roughly 1.5 in. for a 116-in. and 3.0 in. for a 476-in. cylinder.

(5) The bearing capacity of a plate on which a cylinder rolls is greatly affected by slight changes in the physical properties of the material.

(6) The bearing capacity of a steel casting of medium grade and of steel of structural grade can be greatly increased by proper heat treatment.

(7) The tests seem to justify the following formula for the design of plates under loaded cylinders,

$$P = [12{,}000 + 80\,D] \left\{\frac{p - 13{,}000}{23{,}000}\right\}$$

in which P is the safe working load in pounds per inch width of plate, D is the diameter of roller in inches, and p is the yield-point strength of the material in tension in pounds per square inch. For this equation to be applicable the thickness of the plate shall be not less than $.088D$, shall be not less than 120 in. The design load given by the above formula is approximately two-thirds of the minimum load required to produce flow under continuous rolling.

(8) The load bearing capacity of a plate rolled under a cylinder varies as the square of the yield-point strength of the material.

Appendix F—Punched and Reamed Work

In the Proceedings of the fourth annual convention of the Association, Vol. 4, March, 1903, the Iron and Steel Structures Committee's report advised that it was its intention to make a series of experiments to determine the safe limit of plain punching and the amount of reaming needed to remove the injured metal when the said safe limit has been passed. This same report contained a compilation of published and unpublished information on the subject and drew conclusions from the compiled data—pages 195 to 226; but it is not clear that they ever carried out the intentions as to make tests until 1923.

Of all the information published, those tests made by the Edgemoor Iron Company in 1884 and 1893 with punched, reamed and drilled specimens and those by the Bridge and Building Department of the Chicago, Milwaukee & St. Paul Railway are perhaps the most important and significant.

The committee at that time circularized the roads as to their practice in punching and reaming, and the replies of the 24 roads answering lead to the conclusion that reaming was nearly always required in the case of medium steel; and that where punching was allowed, a ⅝ in. thickness was the limit.

Following an extended presentation of tests made in connection with this subject, the committee said that the entire results of the tests would be more conclusive and more consistent if the test specimens had all been taken from material from the same heat. However, the following conclusions may be drawn:

(1) That punching the metal makes it less ductile and raises the elastic limit an appreciable amount.

(2) That the injurious effects of punching may be removed by reaming.

(3) That sub-punching and reaming is as efficient as drilling.

Acknowledgment was made to Lafayette College and to the Bethlehem Steel Company for assistance given to the committee in carrying out the tests.

Discussion

[Chairman A. R. Wilson (Penna.) introduced the report and called upon Subcommittee Chairman J. B. Hunley (C. C. C. & St. L.) to present the Specifications for Steel Highway Bridges].

Mr. Hunley: As the title page explains, this specification was prepared by the conference committee representing the American Association of State Highway Officials and the American Railway Engineering Association. This conference committee considered the tentative A. R. E. A. specification on steel highway bridges which had come out a year earlier, and also the existing specification of the highway officials. We took the best out of both of those specifications and some parts we discarded altogether in both specifications, in order to get what we thought was an improvement.

It is important to have a joint specification, and it was fortunate that we could agree on a specification which was satisfactory to representatives of both associations. I think we all feel, regardless of what attitude the association may take, that it is the best specification which can be obtained at this time. Of course, it may be subject to revisions later, but it is a step forward.

Chairman Wilson: *I move that the Specifications for Steel Highway Bridges be received, approved and inserted in the Manual.*

[Meyer Hirschthal (D. L. & W.) objected to the clearance diagram for through bridges because it provides for a vertical clearance of 16 ft. and in his opinion it establishes a precedent which will be used by public authorities in exerting pressure on the railroads to increase the clearance in subways for track elevation projects. The committee agreed to take this point under advisement.]

L. W. Skov (C. B. & Q.): I wonder if the committee, in its study of live loads, took into consideration the effects of trains of trucks and trailers. Some of the states in the Middle West permit loadings on the highway much heavier than those shown.

[Mr. Skov also objected to the refinement of the clauses covering longitudinal and centrifugal forces requiring that the forces shall be assumed as being

applied four feet above the roadway surface. However, after Mr. Hunley had explained the reason for this provision, and the president declared that Mr. Skov's motion to eliminate this provision had not received a second, the matter was dropped.

Chairman Wilson's motion for the adoption of the specifications as a whole was then put and carried. He then offered the report on welding and it was accepted as information without comment. In offering the report on uses of copper-bearing steel, he read a letter of comment by J. R. Wilk, which was in part as follows:

"We all recognize that investigators for the past 25 years have been searching diligently for ferrous metal that would reduce the cost of excessive corrosion losses. A great deal of progress has been made, but it is important that the practical engineer study the subject carefully before reaching a conclusion as to which of the ferrous metals offered by the producer would best suit the specific purpose he has in mind.

"There is a very recent example showing an astonishing reversal of opinion. In July, 1924, in the Iron Trade Review, there appeared an article concluding that the presence of copper has prolonged the service life of plates on the Leviathan. A month or so ago, or five years later, the Bureau of Standards issued comments based on more complete information. These comments completely reversed the earlier opinion, as follows:

"'The Bureau has been advised informally that in very recent inspection of this ship in dry docks, no distinct difference in the surface conditions of the original copper-bearing steel plate and of the ordinary steel plate without copper, that had been inserted subsequently, was to be observed.

"'This would appear to add further evidence to the conclusion that additions of copper, within the limits usually employed, confer no decided improvement in the corrosion resistance of steel when more or less completely immersed, and would indicate that other factors play an important role in cases where the copper-bearing or non-copper bearing steel shows superior behavior to the other.'

"This substantiates the most common warning by investigators of corrosion. As stated in the Bureau of Standards Circular 253, September 13, 1928:

"'A common error in consideration of corrosion test is to assume that satisfactory or unsatisfactory performance under one set of conditions means that the performance will be similar under another set of conditions. The relative standing of different materials is often altered as the conditions are altered.'

"The Bureau of Standards also states on Page 13:

"'In the American Society for Testing Materials' program of total immersion tests, the same series of materials employed in the atmospheric tests were introduced. . . . The results clearly show that corrosion-resistance of iron and steel when submerged is practically uninfluenced, within the range of the tests, by copper content.'

"It is believed that there is danger of the committee's report being interpreted as unqualifiedly endorsing the selection of copper-bearing steel for all kinds of service, whereas such cases as quoted above clearly demonstrate that such an interpretation would be unwarranted."]

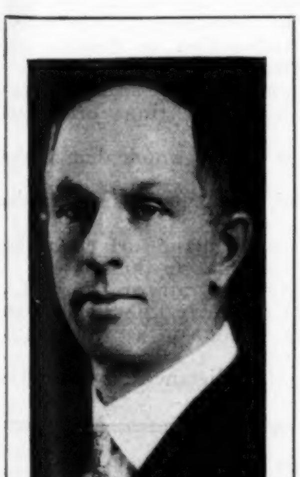
H. T. Livingston (C. R. I. & P.): That paper you just read covers practically the remarks I wanted to make. The information submitted does not actually draw conclusions but it seems to deal somewhat in generalities from which it would be somewhat dangerous to draw conclusions.

President Faucette: Mr. Wilson points out that the comments just read were largely discussed, and the information of this appendix will be received and put into the proceedings.

[Chairman Wilson then offered Appendices D, E and F, and they were accepted as information, after which the committee was excused with the thanks of the association.]

Report on Wooden Bridges and Trestles

Committee revises grading rules for timber and considers supply yards and overhead wooden bridges



W. E. Hawley
Chairman

THE committee's report covered the following subjects:

(1) Revision of Manual (Appendix A).

(2) Simplification of grading rules and classification of timber for railway uses, collaborating with other organizations dealing with this subject (Appendix B).

(3) Advantage of establishing supply yards for standard trestle timbers at various locations throughout the country (Appendix C).

(4) Standardization and simplification of store stock and disposition of material reaching obsolescence, collaborating with other committees and organizations concerned.

(5) Overhead wooden bridges (Appendix D).

It recommended that Subject (1), Appendix A, be adopted; that Subject (2), Appendix B, be received as information and the subject-matter covered by the revisions suggested be withdrawn from the Manual; that Subject (3), Appendix C, be accepted as information and dropped; and that the other subjects be accepted as progress reports.

Appendix A—Revision of Manual

The committee made a number of changes in the grading rules for the classification of timber and lumber for railway uses, and presented the revised rules in full in its report. These rules are so extensive in scope that only a few of the introductory sections are included in the following:

GRADING RULES AND CLASSIFICATION OF TIMBER AND LUMBER

Use Classification

Lumber is the product of the saw and planing mill not further manufactured than by sawing, resawing, and passing lengthwise through a standard planing machine, crosscut to length, and matched.

Lumber is classified as (a) yard lumber, (b) structural timbers, and (c) shop or factory lumber. Different grading rules apply to each class of lumber.

Yard lumber is lumber that is less than five inches in thickness and is intended for general building purposes. The grading of yard lumber is based upon the use of the entire piece.

Structural timber is lumber that is five inches or over in thickness and width. The grading of structural timbers is based upon the strength of the piece and the use of the entire piece.

Shop or factory lumber is lumber intended to be cut up for use in further manufacture. It is graded on the basis of the percentage of the area which will produce a limited number of cuttings of a given minimum size and quality.

Size Classification

Yard Lumber

Strips are yard lumber less than two inches thick and under eight inches wide.

Boards are yard lumber less than two inches thick, eight inches or over in width.

Dimension includes all yard lumber except boards, strips and timbers, that is, yard lumber two inches and under five inches thick, and of any width.

Planks are dimension lumber two inches and under four inches thick and eight inches and over wide.

Scantlings are dimension lumber two inches and under five inches thick and under eight inches wide.

Heavy joists are dimension lumber four inches thick and eight inches or over wide.

Structural timbers are lumber five inches or larger in least dimension.

Manufacturing Classification

Manufactured lumber is classified as rough, surfaced, and worked.

Rough lumber is undressed lumber as it comes from the saw.

Surfaced lumber is lumber that is dressed by running through a planer It may be surfaced on one side (S1S), two sides (S2S), one edge (S1E), two edges (S2E), or a combination of sides and edges (S1S1E) (S2S1E) (S1S2E) or (S4S).

Worked lumber is lumber which has been run through a matching machine, sticker or molder. Worked lumber may be matched, shiplapped or patterned.

Matched lumber is lumber that is edge dressed and shaped to make a close tongue and groove joint at the edges or ends when laid edge to edge or end to end.

Shiplapped lumber is lumber that is edge dressed to make a close rabbetted or lapped joint when laid edge to edge.

Patterned lumber is worked lumber that is shaped to a patterned or molded form.

Definitions of Maximum Defects and Blemishes

The following definitions vary slightly from the definitions of the American Lumber Standards. Definitions of regional lumber associations also vary slightly from American Lumber Standards. This should be considered in making standards.

The terms "Defect" and "Blemish" as applied to wood usually imply the idea of imperfections. These are not always detrimental.

Defect.—Any irregularity or want occurring in or on wood that may lower some of its strength, durability or utility values.

Blemish.—Any mark or formation of wood structure, not classified as a defect, marring the appearance of the wood.

Bark Pocket.—A patch of bark partially or wholly enclosed in the wood. In size it is classified the same as pitch pockets.

Bird's-Eye

"Bird's-Eye."—A small central spot with the wood fibers arranged around it in the form of an ellipse, so as to give the appearance of an eye. "Bird's-Eye," unless unsound or hollow, shall not be considered a defect.

Honeycombing.—Checks occurring in the interior of a piece, often not visible on the surface. On a cross-section they usually appear as slits, or as open pockets whose width may appear very large in proportion to the radial length.

Cross Break.—A separation of the wood cells across the grain, such as may be due to tension resulting from unequal shrinkage or mechanical stresses.

Decay.—A disintegration of wood substance due to the action of wood-destroying fungi. The words "dote" and "rot" mean the same as decay.

Holes in wood may extend partially or entirely through the piece and be from any cause. When holes are permitted, the average of the maximum and minimum diameters measured at right angles to the direction of the hole shall be used in measuring the size, unless otherwise stated.

Pin Worm Hole.—One not over 1/16 in. in diameter.

Medium Worm Hole.—One over 1/16 but not more than 1/4 in. in diameter.

Large Worm Hole.—One over 1/4 in. in diameter.

Chipped Grain.—A part of the surface chipped or broken out in very short particles below the line of cut. It should not be classed as torn grain and, as usually found, shall not be considered a defect, unless it is present in excess of 25 per cent of the area.

Loosened Grain.—A small portion of the wood which has become loosened but not displaced. It occurs on the heart-side of the piece and is a serious defect especially in flooring.

Torn Grain.—A part of the wood which is torn out in dressing, and in depth is of four distinct characters; slight, medium, heavy and deep.

Skip.—An area on a piece that failed to surface.

Hit and Miss.—A series of skipped spots with surfaced areas between, or with skips the entire length when not over 1/16 in. in depth.

Machine Burn.—A darkening or charring of the wood due to overheating by the machine knives.

Mismatched Material.—Worked material that does not fit tightly at all points of contact between adjoining pieces, or in which the surfaces of adjoining pieces are not in the same plane.

Intergrown Knot.—One whose rings of annual growth are completely intergrown with those of the surrounding wood.

Encased Knot.—One whose rings of annual growth are not intergrown and homogeneous with those of the surrounding wood. The encasement may be partial or complete; or pitch or bark.

Pitch.—A poorly defined accumulation of resin in the wood cells in a more or less irregular patch.

Pitch Pocket.—A well defined opening between rings of annual growth usually containing, or which has contained, more or less pitch, either solid or liquid. Bark also may be present in the pocket.

Pith.—The small soft core occurring in the structural center of the log. The wood immediately surrounding the pith often contains small checks, shake, or numerous pin knots, and is discolored; any such combination of defects and blemishes is known as heart center.

Shake.—A lengthwise separation of the wood, which occurs usually between and parallel to the rings of annual growth.

Split.—A lengthwise separation of the wood, due to the tearing apart of the wood cells.

Wane.—Bark, or lack of wood, from any cause, on the edge or corner of a piece.

Warp.—Any variation from a true or plane surface. It includes bow, crook, cup, or any combination thereof.

Cup.—A curve in a piece across the grain or width of a piece. It is measured at the point of greatest deviation from a straight line drawn from edge to edge of a piece. It is known as slight, medium and deep.

Based on a piece 12 in. wide, the distances for the different degrees of cup shall be for:

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Slight cup, a maximum of ¼ in.
Medium cup, a maximum of ⅜ in.
Deep cup, a maximum of ½ in.

Narrower or wider pieces may have the same curvature.

Some of the remaining subjects presented under the general subject of grading rules for the classification of timber, included: American lumber standards for softwood lumber; structural rules; specifications for structural wood joists, plank, beams, stringers and posts; notes on working stresses for structural grades of American lumber standards; tables of allowable working stresses for joist, plank, beams and stringers and likewise for posts and timbers 6-in. by 6-in. and larger; and notes on the safe loads for columns.

Appendix B—Simplification of Grading Rules and Classification of Timber

The committee made the following report:

Collaboration with the lumber industry in its program of standardization has been carried on by members of the committee in continuation of the program which has been going ahead since 1922 under the leadership of President Hoover, then secretary of commerce.

The industry plans to continue the machinery set up for the purpose of revision of standards and also in hope that progress in the hardwood industry will permit of the setting up of standards for this material. The committee desires the continued assignment of this subject.

The representatives of this committee working in harmony with the representatives of the American Society for Testing Materials and in harmony with the representatives of the other branches of the lumber industry have participated in this program throughout the six years. Revisions of previous conclusions have been introduced by others and accepted by the committee, striving to secure the greatest adherence to a unified set of standards. The problem before the industry now is that of education and the securing the maximum use of these standards in place of the older forms.

The revisions for standards of practice, size and quality have been shown in Appendix A, Revision of the Manual.

Material which had been previously accepted for printing in the Manual has been revised by this committee and because of its nature and a desire to reduce this section in the Manual, the subject-matter of this revision is noted for withdrawal from the Manual and for publication only in the Proceedings.

In addition to the above, the committee presented considerable additional data on the determination and calculation of working stresses for timber.

Appendix C—Supply Yards for Standard Trestle Timbers Throughout the Country

In 1927 a questionnaire was sent to members of the Association and a summary of the replies was submitted to the 1928 convention, and is printed on page 510 of the 1928 proceedings. This questionnaire indicated that only a very few of the members of the association who replied favored the establishing of such yards, and the suggestions for locations were so varied that the establishing of either commercial or joint railroad yards does not seem to be a feasible proposition.

Since the 1928 convention the committee has made some investigation of the prices of timbers purchased from commercial yards, as compared with mill prices, and it was found that the increase is about one-third. It is to be expected that the handling of material through a joint railroad yard would increase the cost by approximately this same amount.

The 1921 proceedings show a statement of the sizes of standard bridge timbers used by 53 roads, which shows a diversity of sizes and lengths as follows:

Caps	13 different sizes
Stringers	37 different sizes
Ties	15 different sizes
Guard rail	9 different sizes

The 1927 questionnaire mentioned above brought out evidence to show there had been very little progress toward decreasing the number of sizes.

The committee has also found that in general the railroads which have any large amount of timber trestles have store yards of their own with facilities for prompt loading, and the replacements necessarily keep a certain amount of material moving and this is sufficient to take care of emergency needs. In some cases it is found that such material is supplied to other railroads in emergencies.

Conclusion

With the data as given above, the committee feels that it is not proper for the railroads to attempt to establish joint supply yards, and that with the cost and diversity of sizes it is more satisfactory to purchase material from the mills than from commercial yards, and recommends that this subject be dropped from further consideration.

Appendix D—Overhead Wooden Bridges

On July 6, 1928, the following questionnaire was addressed to representative railways:

(1) Do you at present construct such bridges of timber?
(2) Do you consider density of population in the adoption of loads for which you design such bridges?
(3) What type of wearing surface have you found most suitable for floors of such bridges?
(4) Do you use the A.R.E.A. formula (page 166, proceedings, 1923) for determining the load carried by one stringer? If not, what formula is used?
(5) Please forward a copy of your standard plans and specifications or of a typical plan of such bridges on your railway.

Eighty-five replies have been received, and, of these 35 roads reported that they build such bridges of timber, and 50 that they do not. Of the latter, nine have no such bridges on their line. Six state definitely that their reason for not building such bridges of timber is on account of other types of construction being more permanent.

This would indicate that the value of timber for structural purposes may be underestimated. Of the railways that reported having overgrade highway bridges, 46 per cent use some timber construction.

There are many wooden buildings that have given service for more than a century. A vast amount of timber that has been buried below the ground water line or submerged in streams or lakes is still in perfect preservation after hundreds of years. It is, therefore, evident that the useful life of timber in structures is dependent upon preservation and protection from mechanical wear, or protection from the destructive elements.

Air, moisture and warmth are necessary for decay in timber. Eliminate any one of these and the life of timber will be indefinite.

The committee believes that, with the development of paint spray machines, it will be feasible, practical and economical to spray timber structures with chemicals the same as used in the original treatment, at intervals so as to make the life of the structure entirely suitable to the purpose for which it was originally built.

With this method the chemical can be put in checks, joints and bearings where decay usually starts and timber so treated after it has been in service sufficiently long to have completed the shrinking and checking, common to the material, should require additional spraying only at considerable time intervals. Few apply preservatives to structural timber once it is in the structure, except for esthetic purposes.

Of course, a timber structure is subject to destruction by fire, but there are wood preservatives that are also fire retarding, and, since the floor of highway bridges can easily be made fairly weatherproof, the tendency for such preservatives to leach out is much less than in more exposed structures.

As to fire hazard of creosoted timber, in the 1925 proceedings A.R.E.A., report of the Committee on Wood Preservation, the following statement occurs:

"We have a few notable examples to prove that creosoted material when dry is not as suspectible to fire as untreated material, and it is no harder to put out than untreated material. In most cases creosoted timber will stop burning after the excess oil has passed out of the wood, as it only burns as long as the heat converts the oil into gas, and when the excess oil is exhausted the fire goes out."

Due to the ease of framing, in original construction, the facility with which such structures can be reinforced, widened, repaired and trued up, timber is well suited for the construction of overgrade highway bridges.

It is admitted, of course, that, as any material of construction, timber has its limitations, and these apply particularly to beam spans. However, it also is ideally suited to many types of structures, and it is thought that for these it should not be overlooked.

The committee feels that the timber overgrade highway bridge is not necessarily a temporary structure, and that it has a very definite field of use.

The committee expects to develop plans of such structures so that they may be used as a guide, and solicits criticism and suggestions from the membership.

Discussion

[The report of the committee was presented by W. E. Hawley (D. M. & N.) with Vice-President Louis Yager (N. P.) in the chair, while Subcommittee Chairman H. Austill (M. & O.) submitted the subject matter in Appendix A.]

Mr. Austill: The changes, as stated, are largely editorial. The committee will be glad to answer any question. *I move the adoption of Appendix A, Revision of Manual.*

[Without discussion *the motion was put to a vote and passed.* The matter under Subject No. 2 was presented by John Newlin (Forest Products Laboratory).]

Mr. Newlin: In applying the specifications, a great many people are like myself; they want to know the principles back of them. This appendix has been prepared to give those principles. The first part of the appendix gives the principles back of grading rules in words, and then, there is some numerical evaluation of these principles, so that if you have timbers which do not meet the specifications, you can assign working stresses to them.

The last part of the appendix comprises charts and equations, which make this application a little bit easier. I think it has great value for those who really want to understand the principles back of the specifications.

[The material was received as information without discussion, following which the report of the Committee on Subject No. 3 was presented by S. F. Grear (I. C.) and accepted as information, and dropped. The report on Overhead Wooden Bridges was presented by Subcommittee Chairman Austill, as information.]

Mr. Austill: The response to our questionnaire was most satisfactory, on the whole, but it was somewhat unsatisfactory and disappointing as to wearing surface. Most replies stated merely the type that has been used, without comment.

In connection with state highway departments, the state of Alabama has developed a design in which the bridge is built of creosoted piles and timber throughout, except that reinforced concrete slabs are used for the wearing surface; the curb and hand rail are also of reinforced concrete. This appears to prove very economical and the cost seems about equal to that of a four-inch timber floor with some form of wearing surface. The committee hopes to develop some plans during the year that may be of interest to you.

B. R. Leffler (N. Y. C.): We railroad men should consider the utility of timber for overhead bridges. We have been passing, or are passing, through an age of poor concrete, and I am afraid that we have overlooked the benefits of well designed overhead timber bridges, especially treated bridges. About 1906, under my jurisdiction, a number of overhead bridges were built between Chicago and Buffalo, N. Y. These were built of fir treated with Carbolineum. We are now removing those bridges after 23 years of service. These bridges carried about the heaviest highway traffic we have.

With the present method of thorough treatment I am bold to say that such treated bridges will last just as long as concrete, at least as long as some of the concrete structures we have been building. I don't think we should allow our experience with untreated timber in the past to measure the benefits that may be derived from properly designed and properly framed and treated timber bridges.

My object in talking about this is to bring out the fact that, especially in the eastern states, there is a prejudice against timber bridges on the part of state highway departments, and in approaching joint propositions these departments seem to be against timber bridges and for concrete bridges.

Another important feature, the cost for these bridges is only about a third to a half the cost of a concrete bridge. It is also a fact that in the western and southern states where timber is more accessible, treated timber bridges have been very favorably considered and are being built. I think we eastern roads should also give this question favorable consideration.

Chairman Hawley: In our district the tendency has been to build so-called permanent bridges, and then we find that a revision of the road plan sometimes results in changes in the bridges. If the bridges had been built originally of timber, considerable money would have been saved at the time of change.

In conjunction with the remarks by Mr. Ford yesterday, there has been no definite settlement as to the proper division of costs of overhead bridges, and a timber bridge costing less money in the present arbitrary method of division of costs, will probably prove more economical in many cases for both the public and the railroad, than a more permanent structure.

The committee is open-minded on this subject. It knows that wooden bridges will not cover all requirements at all overhead crossings of railroads, but where wood is suitable, we want to bring in recommendations which will enable the engineers to give wood fair consideration in designing an economical crossing.

Mr. Austill: We had proposed crossings in which the state proposed to divide the expense "fifty-fifty," and submitted plans for reinforced concrete. We said that material which would carry our loads was good enough for us in our own trestles, and that we would contribute 50 per cent of the estimated cost of a creosoted timber structure. The highway department, after some consideration, agreed to these terms and built the bridge of reinforced concrete. We paid 50 per cent of the estimated cost of a creosoted timber structure at a large saving to the railroad. Since that time we have made three agreements on the same basis, and since then, the states have built two bridges of creosoted timber crossing our line.

Vice-President Yager: The discussion indicates clearly that there is not much foundation for the fear in some quarters that the usefulness of this committee might soon terminate. They are finding more, and better and effective uses for timber. The committee is excused with the thanks of the association.

Report of the Committee on Masonry

New specifications for reinforced concrete culvert pipe are presented for publication in the Manual

C. P. Richardson
Chairman

THE committee submitted reports on the following subjects:

(2) Principles of design of concrete, plain and reinforced, for use in railroad structures.

(3) Study and report upon progress in the science of concrete manufacture.

(6) Study and report upon general practices for waterproofing railway structures.

Under Appendix A, the committee recommended: (a) That Section I on "Design of Reinforced Concrete Columns" be adopted and printed in the Manual; (b) That the subject-matter in Section II, entitled "Tentative Standard Specification for Reinforced Concrete Culvert Pipe, be adopted and printed in the Manual; and (c) That Section III on Reinforced Concrete Flat Slabs be accepted as information.

Under Appendix B, it recommended: that the definitions of "Special Cements and Admixtures" be adopted and printed in the Manual; and that the report on Moisture and Bulking of Aggregate be received as information. It also recommended that Appendix C be received as information.

Appendix A—Principles of Design of Concrete

This subject was discussed under the two heads, columns and culvert pipe. Under the first head, columns, the report in part was as follows:

Limiting Dimensions.—Unless designed as long columns, reinforced concrete columns shall not be longer than 12 times the lateral dimension. Continuous columns shall have a minimum diameter or thickness of 12 in. Non-continuous columns shall have a minimum diameter or thickness of 6 in.

Design of Spiral Columns.—(a) The permissible axial load on columns reinforced with longitudinal bars and closely spaced spirals enclosing a circular core shall not be greater than that determined by formula 36.

$$P = A_e[1 + (n-1)\,p]\,f_e \qquad (36)$$

in which A_e is the area within the outer circumference of the spiral hooping, and the values of f_e, as found by the formula,

$$f_e = (.25 + 12p')\,f'_e \qquad (37)$$

in which, f'_e = the ultimate compressive strength of the concrete in 28 days, and p' is the ratio of the volume of spiral reinforcement to the volume of the column core.

(b) The longitudinal reinforcement shall consist of at least six bars of minimum diameter of ½ in., and of an effective cross-sectional area not less than 0.01, nor more than 0.06 of that of the core. The number of longitudinal bars concentrated in the ring at the periphery of the core shall be governed by the spacing requirements of Section 53. When the ratio of reinforcement in a spirally reinforced column is such as to require two rings of bars, special drawings illustrating the proper distribution of steel shall be shown on the detail plans. Splices in longitudinal reinforcement shall occur only where the column is laterally supported and shall provide sufficient lap to transmit the stress by bond, but not less than 24-bar diameter for deformed bars, and 30 diameters for plain bars.

(c) The ratio of the spiral reinforcement to the core shall be not less than .005 nor less than one-fourth the volume of the longitudinal reinforcement. Spiral reinforcement shall conform to the provisions of Section 14 of these specifications. The pitch of the spirals shall not be greater than one-sixth of the diameter of the core and in no case more than three inches.

(d) Reinforcement shall be protected everywhere by a covering of concrete cast monolithic with the core and which shall have a minimum thickness of 1½ in.

Bending in Columns.—(a) Stresses due to the bending moments in interior and exterior columns shall be determined on the basis of loading conditions and end restraint, and the columns designed for the combined bending and axial load stresses.

(b) In flat-slab construction, the least dimension of the column shall be not less than one-fifteenth of the average center to center span, nor less than 16 in. except for roof columns which shall be not less than 12 in. in least dimension. For known eccentric loads or unequal spacing of columns, computations of moments shall be made accordingly. Wall columns in flat-slab construction shall be designed to resist a bending moment of $Wl/35$, where W is the total load, dead and live, and l equals length of span. Any counter moment due to the weight of the structure that projects beyond the column center line may be deducted from the moment computed as just described. Resistance to the bending moments shall be divided between the columns immediately above and below in direct proportion to the values in their ratios of I/h.

(c) Recognized methods shall be followed in calculating the stresses due to combined axial load and bending. The column section shall be not less than that required where axial load alone is considered.

Long Columns.—(a) The permissible working load on the core in axially loaded spiral or tied columns which have a length greater than 12 times the least dimensions of the column (12D) shall be not greater than that determined by formula 39.

$$\frac{P'}{P} = 1.33 - \frac{h}{36D} \qquad (39)$$

Following this part of the report the committee presented the second report of the Joint Concrete Culvert Pipe Committee, composed of representatives of the A. R. E. A. and other organizations which it recommended be printed in the Manual.

For lack of available space, only those sections of the specifications dealing with design, and with workmanship and finish, are given in the following:

Specifications for Reinforced Concrete Culvert Pipe

Design

9. The pipe shall be designed in accordance with the following assumptions:

(a) That the design load is equivalent to a vertical load uniformly distributed over the internal horizontal projection of the pipe, that the pipe is likewise uniformly supported and that no allowance is made for side pressure.

(b) The uniform load for the standard reinforced concrete culvert pipe shall be 2,000 lb. and for the extra strength reinforced concrete culvert pipe 4,000 lb. per sq. ft., respectively.

(c) The working stress per square inch in compression for the concrete shall not exceed three-eighths of the strength of concrete upon which the design is based.

(d) The ratio (n) of the modulus of elasticity of steel to that of concrete shall be 12 for concrete having an ultimate compressive strength at 28 days of 2,750 lb. per sq. in. and 9 for concrete having an ultimate compressive strength of 4,000 lb. per sq. in. or greater. Intermediate values of "n" shall be proportional to the strength of concrete assumed in the design.

(e) The working stress for cold-drawn steel wire shall not exceed 27,500 lb. per sq. in. For billet-steel, intermediate and hard grades, the working stress shall not exceed 20,000 lb. per sq. in.; and for billet-steel, structural grade, the working stress shall not exceed 18,000 lb. per sq. in.

(f) The distance from the center of the reinforcement to the

nearest or tension surface of the concrete shall not be less than ¾ in. for pipe 12 in. or less in diameter, or less than 1 in. for pipe more than 12 in. in diameter.

(g) The distance from the center of the tension reinforcement to the compression surface of the concrete and the area of the reinforcement shall not be less than that required by the formula—

$$\frac{wd}{16} \times \frac{d+t}{12} = jAtf_s$$

in which w = uniform vertical load in pounds per square foot and bottom of pipe.
d = internal diameter of pipe in inches.
t = distance from the center of the tension reinforcement to the compression surface of the concrete in inches.
A = sectional area of tension reinforcement in square inches per lineal foot of the pipe.
f_s = tensile stress in the reinforcement in pounds per square inch.
j = ratio of the lever arm of the reinforcements to "t" as determined by the usual formulas.

10. The shell thickness and the amount of circumferential reinforcement shall not be less than that given in the design tables for the classes and sizes of pipe and the strength of concrete therein specified.

11. Manufacturers may submit to the consumer or purchaser, for approval, designs based on strengths of concrete other than those given in the design tables. Such alternate designs shall comply with the design requirements given in Section III of these specifications. In no alternative design, however, shall the shell thicknesses be less than those given in Table II, nor shall the strength of concrete be less than that given in Table I.

12. Pipe of the internal diameters listed in the design tables shall be considered standard sizes for culvert construction. In elliptical pipe, the inside diameter at the minor axis shall be equal to the diameter of the corresponding size of circular pipe.

13. The ends of the pipe shall be of such design that the pipe when laid shall make a continuous conduit with a smooth and uniform interior surface.

14. When a single line of circular reinforcement is used in circular pipe, it shall be placed at the center of the pipe shell. When two lines of reinforcement are used in circular pipe, one shall be placed near the inner and one near the outer surface of the pipe. The single line of elliptical reinforcement used in circular pipe, or the single line of circular reinforcement in elliptical pipe shall be placed near the inner surface at the "top" and "bottom" of the pipe and near the outer surface at the sides.

15. Each line of circumferential reinforcement shall be assembled into a cage and have sufficient longitudinal bars or members, extending through the barrel of the pipe, to afford rigidity and maintain the reinforcement in exact shape and correct position within the form.

16. The reinforcement shall be lapped not less than 30 diameters, or if welded, the joints shall develop the full strength of the reinforcement. The spacing center to center of adjacent rings of circumferential reinforcement in a cage shall not exceed 4 in. up to and including pipe 48 in. in diameter, nor exceed the shell thickness for larger pipe, and shall in no case exceed 6 in.

17. The bell shall have a circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

Workmanship and Finish

18. Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The planes of the ends of the pipe shall be perpendicular to their longitudinal axes.

19. (a) Variations of the internal diameter shall not exceed 1½ per cent nor shall the shell thickness be less than that intended in the design by more than 5 per cent at any point.

(b) Variation in the position of the reinforcement cages shall not exceed ¼ in. from the position provided in the design, nor shall the cover on the reinforcement be less than ¾ in. at any point.

The specifications, which were termed tentative, were based on many tests of full size pipe procured from different manufacturers, made as nearly as possible in accordance with the proposed design. These tests showed that pipe complying with the strengths specified could be made with less reinforcement than was required by the unit stresses: 16,000 lb. per sq. in. for steel, of the 1926 specifications. The unit stresses were, therefore, raised to those of the present specification, and are based upon the results of the tests of pipe made under the proposed specifications.

Design tables for two classes of pipe were given, and the committee stated that pipe for any conditions of loading and material could be designed under the method proposed.

In this appendix, the committee also submitted as information, a method of design for girderless flat slabs for track construction.

Appendix B—Science and Art of Concrete Manufacture

The committee stated that in concrete construction certain results are often desired which will not be obtained in concrete from ordinary Portland cement under usual conditions. At times it is desired to place structures in service relatively soon after the concrete is placed. It may be desirable to secure concrete having unusual water tightness and small absorption, or the structural design may be such that high degree of workability is of importance.

As a consequence, cement manufacturers have developed several brands of special cements. Other companies have placed on the market materials in the form of admixtures to Portland cement.

In order to differentiate between these materials, the committee presented the following definitions covering special cements and admixtures:

Quick Setting Portland Cement.—A Portland cement

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M. Hirschthal, concrete engr., D. L. & W., Hoboken, N. J.
Hans Ibsen, spec. bridge engr., M. C., Detroit, Mich.
A. C. Irwin, mgr. ry. bur., Portland Cement Assn., Chicago.
G. M. Johnson, br. & bldg. supvr., Wabash, Montpelier, Ohio.
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L. W. Skov, office engr., bridge dept., C. B. & Q., Chicago.
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I. F. Stern, cons. engr., First Natl. Bk. Bldg., Chicago.
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C. C. Westfall, engr. bridges, I. C., Chicago.
C. C. Williams, dean applied science of U. of Ia., Iowa City, Ia.
P. H. Winchester, div. engr., N. Y. C., Syracuse, N. Y.
J. J. Yates, bridge engr., C. R. R. of N. J., Jersey City, N. J.

*Died Dec. 28, 1928.

which stiffens and sets more quickly than ordinary Portland cement under similar conditions.

High Early Strength Cement.—A cement which will produce concrete having as high strength in a few days as ordinary Portland cement in twenty-eight days, used in the usual manner and proportions.

Supercement.—A trade name for a cement to which a small percentage of "Catacoll" (tannin) has been added with the gypsum at the time of grinding.

Admixture.—Any material, other than cement, water, or aggregate, added to the concrete mixture to effect certain changes in the properties of the concrete.

Integral Waterproofing.—Any admixture other than cement, water or aggregate added to the concrete mixture for the purpose of increasing the water tightness of the concrete.

Accelerators.—Any admixture other than cement, water, or aggregate added to the concrete mixture for the purpose of securing a more rapid hardening of the concrete.

The advantages claimed by the proponents of the various admixtures are:

(1) That they increase the amount of colloidal material resulting from the hydration of cement.

(2) That they lubricate the mass and allow the use of dryer mixes with consequent higher strength and density, thus waterproofing the mass.

(3) That they repel moisture by breaking down capillary action and thus preventing absorption.

(4) That they stimulate the process of hydration of the cement with consequent rapid hardening, waterproofness and greater strength.

(5) That they fill the minute channels, voids or pores and so increase the workability.

The committee reported that published test data on the above subject were meager and lacking in essential particulars, in view of which it felt justified in drawing the following conclusions of its own:

(1) The use of admixture should not be taken as a reason or excuse for neglecting proper inspection or for violation of the principles governing the production of good concrete.

(2) The advantages claimed for admixtures may be secured by proper selection and proportioning of aggregates, water control, proper placing and curing and the use of enough cement paste to secure workability.

(3) With aggregates not having enough fine material for workability this deficiency may usually be made good more economically than with proprietary admixtures.

As the special cements and admixtures are employed in the hope of securing special results, their use becomes a question of economics. Their effects on concrete over long periods of time are of the utmost importance and are still to be determined.

Moisture and Bulking of Aggregate

In discussing this subject, the committee said that in applying the water-cement ratio methods, it is necessary that the amount of water added to the mix for each sack of cement be corrected for the amount of water introduced or subtracted by the aggregates. Usually the fine aggregates—and often the coarse aggregates—carry important amounts of water which must be determined and reckoned with the water to be added at the mixer.

Fine aggregates bulk considerably, depending upon the moisture content and somewhat upon the method of measurement. Once the desired mix is established, changes in the bulking of the sand will produce somewhat different true proportions. Basic proportions, determined by actual trial to cover a certain kind and grading of aggregates, are usually given in terms of dry rodded volumes. These volumes, must, therefore, be corrected for bulking.

Probably the most accurate method to find the moisture content of an aggregate is to weigh a sample before and after drying. The difference between these weights is the contained moisture content.

The committee pointed out that several methods have been tried, and others suggested, to determine moisture content quickly, and after outlining each of these methods briefly, it offered the following conclusions:

Conclusions

Moisture in Aggregate.—A comparison of all methods indicates that the best results are obtained with those methods requiring the simplest manipulation; for example, the drying out method gives the most accurate results for determining the moisture.

For moisture determination by the displacement methods, Chapman Flask, P.C.A. container, etc., rank next in point of accuracy. The specific gravity method with the hydrometer ranks next in accuracy, and the electrical conductivity method is too inaccurate.

The "Hunt" method by volume and displacement, as noted in 3(f), however, has been used very advantageously on a large number of jobs, both large and small, and although very simple in application, has proven sufficiently accurate for all practical purposes.

Bulking of Aggregates.—Any of the methods given are sufficiently accurate for the determination of bulking. The specifications require that a workable mix be always obtained; that is, the proportion of fine and coarse aggregate can be changed to suit job conditions so long as the water-cement ratio is carefully preserved. In other words, the bulking can be taken care of by an experienced inspector who is able to judge the workability from the behavior of the concrete. A close check should, however, be kept on the moisture content of the aggregates to insure as little variation as possible in the water ratio.

Appendix C—Waterproofing Railway Structures

The committee reported that considerable time has been devoted to the study and consideration of the data on the waterproofing of railway bridge decks, obtained through a questionnaire and submitted with the report of last year.

It believes that the specifications for Waterproofing and Drainage of Solid-Floor Railway Bridges, presented by the Committee on Iron and Steel Structures, and adopted by the association at its convention in 1927, marks an important step toward establishing uniformity in practice. It feels, however, that, in collaboration with the Committee on Iron and Steel Structures, the several types of waterproofing recommended in this specification may be condensed and that additional study on special treatment of flashings, construction and expansion joints and other related matters may be made in the interests of economy and in practice. The committee reported progress on this subject.

The report of the committee in this appendix also included the tabulated answers to a questionnaire regarding the waterproofing of bridges, which was sent out last year and inadvertently omitted from last year's report.

It reported that, owing to the lack of a recommended practice for waterproofing and damp proofing of railway structures other than bridge decks, it failed to find any general practice for this class of work. In view of this, it stated that a questionnaire form on this subject has been prepared to obtain sufficient data on which to base a recommended practice. From the data already at hand, it is believed that much valuable information on this subject will be obtained by this method.

Discussion

[In introducing the report Chairman C. P Richardson (C. R. I. & P.) stated that, during the discussion of the committee's report at the 1928 convention, the question arose as to whether the railway or the contractor should furnish cement on contract jobs. Since the committee had not reported on this subject in the matter in the bulletin, Chairman Richardson presented the views of the committee orally.]

Chairman Richardson: The committee feels that the matter of the railway or the contractor furnishing the cement on masonry work is one that each railway must necessarily decide for itself, having in mind economies in the original cost as well as other thoughts which need not be mentioned.

I believe it must be conceded that the matter of skimping in the use of cement can be dismissed in view of the adoption of the water-cement ratio of control in the strength of concrete, as the representative of the railway company is in charge and is watching the manufacture of concrete today.

I do not mean to preclude any further discussion of this subject, and if there is a lively interest in ascertaining the general practice throughout the country, the committee will gladly send out a questionnaire. It is the thought of the committee that the answers received from this questionnaire would be just a matter of practice and not of sufficient uniformity to allow of a conclusion which would apply to railroads in general.

The first section of the Committee on Masonry report on Principles of design of concrete, plain and reinforced, for use in railroad structures, will be presented by Mr. Meyer Hirschthal, (D. L. & W.) chairman of the subcommittee.

Mr. Hirschthal: This year the committee presents the principles of the design of concrete, plain and reinforced, as applied to columns, for adoption and printing in the Manual. *I move for such adoption the matter in the various sections under the heading of Columns,* as follows: "121—Limiting Dimensions; 122—Unsupported Length of Columns; 123—Design of Spiral Columns; 124—Design of Columns with Lateral Ties; 125—Bending in Columns; and 126—Long Columns."

[*The motion was carried.* Mr. Hirschthal then presented the Specifications for Design of Culvert Pipe and *his motion that they be approved for inclusion in the Manual was carried.*

Mr. Hirschthal then presented the report on Reinforced Flat Slabs as information and as a tentative method of design, following which the report on the progress in the science and art of concrete manufacture was presented by Subcommittee Chairman L. W. Skov (C. B. & Q.) *whose motion that the definitions of special cements and admixtures be approved for insertion in the Manual and that the other matter be received as information, was carried.*]

B. R. Leffler (N. Y. C.): If it is in order I should like to add a few remarks concerning the science and art of concrete manufacture. It might be of interest to mention a few of the recent hopeful developments during the past year. At the June convention of the American Society for Testing Materials, a paper was presented by a Kansas state engineer on the subject of Permanence of Concrete. This engineer took a Frigidaire freezing apparatus and subjected specimens of concrete to alternate freezing and thawing action, bringing out that concrete made with more than seven gallons of water to a sack of cement would not hold up under such conditions.

The next important paper at the same meeting pertained to the testing of concrete subject to alkaline water. Those tests are probably not final, but they are very suggestive. About 36 different brands of cement were tested and it was found that not over 12 of the brands held up well under the sodium sulphate tests. I mention these two papers in the hope that the committee will keep watch of these subjects, as they comprise two lines of investigation which should bring out some interesting results.

The third paper was presented by Roderick B. Young, a well-known authority, in Canada, on the permanence of concrete. His study was based on the observation of existing structures, not on laboratory tests, and pointed to a conclusion that you cannot make permanent concrete with less than seven sacks of cement per cubic yard of concrete placed.

I think the water-cement ratio as a means of bringing about good concrete is all right if used with care, but in my work I don't follow that rule rigidly. I adopted this rule: We are using six gallons of water to a sack of cement and that covers the moisture in the aggregate which, roughly, runs about two gallons. Such concrete at the end of 28 days will test all the way from 2,500 to 3,000 lb. and we use it in ordinary bridge work.

My viewpoint is to place a high value on permanency and let strength take care of itself. There is no need to worry about the strength. The danger in the water-cement ratio, as I look at it, lies in the fact that it gives a resemblance of an exact science to the thing. The French engineers, many years ago, long before the water-cement ratio was thought of, knew the bad effects of excess water in cement. Don't put too much emphasis on strength; put it on permanency. That is the most hopeful line of endeavor in good concrete.

Chairman Richardson: I am very glad that Mr. Leffler took the time for his remarks. We are short of time, but I feel that we are apt to pass over too lightly these matters contained in this progress report of this subcommittee. It is of interest to everybody, but when nothing is said a lot of the main facts in this subject are lost.

Mr. Hirschthal: There is one point I want to add to this reply of our chairman in connection with Mr. Leffler's criticism. The trouble with concrete, as far as permanence is concerned, is not so much in the ingredients that are put in the concrete as in the workmanship. There is a tendency on the part of railroads in particular to rush concrete work, and, whereas it is perfectly well understood that it takes a carpenter to put up woodwork, a steel man to put up steel and a mason to put up brick or masonry, concrete is supposed to be put up by anybody who is around, with very little or no attention. If some attention were paid both by the inspector of the railroad and the superintendent for the contractor to seeing that the working of the concrete in its forms was so thoroughly done that there would be a thorough conglomeration of all the material and so that the concrete would set up into a real stonelike texture, we would get the quality of permanence. That is testified to by the fact that in cement finish work where machinery is used, there results a concrete which is far superior to the ordinary concrete done by manual labor on ordinary bridge work.

Vice-President Yager: I desire to remove an impression that the chairman may incidentally have given. There is plenty of time for such discussion as this. It is very interesting and I am sure profitable, and will be utilized by the committee in its further labors on this subject.

Chairman Richardson: Before passing from this subject I want to state that the committee took hold of this subject of high early strength cements and admixtures with some hesitation and in its report brings out the claims made as a result of the various

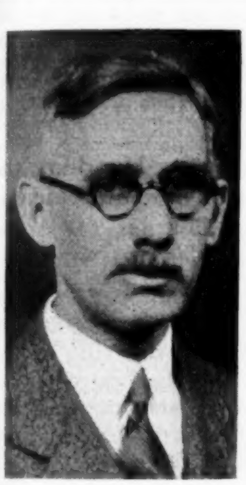
uses of these admixtures. I have in my hand about five typewritten pages of discussion of this report on admixtures. It was received from a well-known producer of diatomaceous silica and, as it is rather lengthy, I will not read it and would not suggest it being put into the proceedings. I want to assure the writer of this discussion that it will be given consideration by the committee during the coming year.

The third section of the committee's report, Appendix C, covers the subject of General Practices for Waterproofing Railway Structures. This report is presented for information and includes a brief progress report showing the activities of the committee; also a portion of a questionnaire which was published last year in the report but unintentionally left out in publishing the proceedings.

[The committee was then excused with the thanks of the association.]

Report on Records and Accounts

Special attention is given to methods and forms necessary to meet requirements of I. C. C.



J. H. Hande
Chairman

THE committee presented reports covering the following subjects:

(1) Revision of Manual (Appendix A).

(2) Collaborate with other committees in the preparation and design of forms pertinent to their work (Appendix B).

(3) Changes or revisions in I.C.C. Classification of Accounts (Appendix C).

(4) Methods and forms for gathering the necessary data for keeping up to date the physical and valuation records of the property of railroads with respect to: (a) Changes made necessary in government regulations; (b) Simplicity and practicability of use (Appendix D).

(5) Methods and forms for handling the Interstate Commerce Commission's requirements under Order 15100—Depreciation charges of steam railroad companies (Appendix E).

(6) Study statistical requirements of the accounting, operating or other departments with respect to maintenance of way and structures (Appendix F).

It recommended that Appendices A and C be received as information; that Appendices D and E be accepted as progress reports; that Sections (a) and (c) of Appendix B be accepted as information and that the specifications for forms in Section (b) of this appendix be adopted for inclusion in the Manual; and that Appendix F be received as information, except the form included, which it presented for adoption and inclusion in the Manual.

Appendix A—Revision of Manual

The committee reported that, in connection with the new Manual in the course of preparation, it has read and compared with proof sheets of its section, and offered no recommendations for revision this year.

Appendix B—Preparation and Design of Forms Pertinent to Their Work

The committee this year gave special consideration to its scope and field of activity with a view to determining the points of contact with the work of other committees so as to outline clearly the best methods by which to regulate its collaborations.

With that in mind, this year's assignment was divided into three sections:

(a) Check the list of forms and records reported last year as required in the several branches of the engineering department in their routine operations, and recommend others that should be added to that list.

(b) Develop general specifications to which forms submitted in collaboration and developed by the Committee on Records and Accounts should conform.

(c) Specific collaboration with other committees.

Under Subject (a) the committee referred to forms under the classification, Design and Construction Department, Maintenance Department and Valuation Department, already appearing in the Manual and subsequent bulletins, and stated that it was its purpose to compile a list of other records or reports used in routine railway operations, included under the above general classifications, for which forms should be designed and included in the Manual.

In view of this, the committee listed four additional forms under the classification, Design and Construction Department, and five additional forms under the classification, Maintenance Department. No additions were recommended under the classification, Valuation Department.

Under subject (6) in this appendix, the committee reported that in the work of collaboration with other committees and in the design of forms by itself, was it evident that the work could proceed with more unformity if general specifications were adopted to which the forms thus designed should conform. For this purpose, therefore, the committee presented specifications for the design, arrangement and printing of forms, which it recommended be adopted and published in the Manual.

Under Subject (c) of Appendix B, the committee reported progress, and stated that letters were sent to the chairmen of all committees, inquiring as to what collaborations were desired in connection with the design of forms. Replies received to these letters indicated that this year no committee was contemplating the design or preparation of any form.

Appendix C—Progress Upon Changes or Revisions in I.C.C. Classification of Accounts

The report on this subject was a continuation from November 9, 1927, of the report prepared last year and printed in Bulletin 304, pages 766 to 850 inclusive. In general the report was a summary of prog-

ress to date (October 16, 1928), and, like the preceding report was presented without comment or discussion.

Appendix D—Methods and Forms for Keeping up to Date the Physical and Valuation Records of the Property of Railroads

The committee's report on the subject of this appendix, had respect to: (a) Changes made necessary in government regulations, and (b) Simplicity and practicability of use.

Under (a) the committee gave the history of the valuation orders of the Interstate Commerce Commission and then made the following comments:

Our last year's report included the following subjects: (5) Mandatory forms required by Federal regulations, and (6) List of units of railway property.

These two subjects are fundamental to all methods and forms designed for gathering data for keeping up to date the physical and valuation records of the railroads.

Since the committee made its report on the above subjects, the Interstate Commerce Commission has, as previously outlined in this report, issued (1) Supplement No. 4 to Valuation Order No. 3, Second Revised Issue.

(2) Supplement No. 5 to Valuation Order No. 3, Second Revised Issue.

(3) Outline of plan for bringing land valuations to December 31, 1927, and such other date or dates as may be fixed by the director of valuation.

(4) Valuation Order No. 24, and

(5) Valuation Order No. 25.

These orders and supplemental orders affect very materially portions of our report made last year. In our report this year, therefore, we offer forms and subject matter different from that presented in its last report, to be considered as supplemental thereto until such time as methods and conditions have become stabilized to the extent that a comprehensive report may be presented for inclusion in the Manual.

As stated, the committee followed this part of its report with a carefully prepared description of the five orders of the commission, listed above.

Under Subject (b) in this appendix, "Simplicity and Practicability of Use," the committee made a study of the possible savings that might be effected through a reduction in the number of valuation sections now in use on the railroads, and after a general discussion of this subject, reported that, in order to learn to what extent the number of valuation sections, as originally assigned, has proved burdensome, and also how much the burden of complying with the various requirements of the Interstate Commerce Commission might be lightened by combining and thus reducing the number of valuation sections, it had sent a questionnaire to 51 of the larger roads requesting that the various features which might involve advantages or disadvantages be given full consideration in formulating a reply.

From the replies to this questionnaire, the committee made the follow statements:

The responses from the various railroads indicate that 19 per cent in number favor a reduction in the present number of valuation sections, the number of miles represented by those favoring such a reduction being in almost the same ratio. There appears to be a good reason why so small a percentage favor reduction and that is that combinations or consolidations of valuation sections as originally assigned have been made in the past to such an extent that further reductions are not desirable, such reductions running as high as 60 per cent. The estimated saving was in all cases small, ranging from 0 to 5 per cent.

Committee concluded that no general recommendation for a combination or a reduction in the present number of valuation sections should be made. It said that there are specific instances where certain combinations are logical and peculiar to a particular railroad. In such cases it becomes the subject of study and determination for the individual railroad as to whether the advantages of such consolidation will outweigh the disadvantages.

Appendix E—Methods and Forms for Handling the Interstate Commerce Commission's Requirements Concerning Depreciation Charges of Steam Railroads

The committee made a study and analysis of this subject, but in view of the present indefinite status of the Order, confined its activities to preparing a history of the subject in question, a bibliography of data published on the subject, and a statement of the requirements of the Order and probable method necessary to inaugurate and currently carry out the provisions of the Order.

Toward the close of its report, the committee made the following general statements:

In a study of the Commission's plan of depreciation accounting, consideration has been given to the extent and magnitude of the work required of carriers. The first step in complying with the Order is the inaugural work, or the preparation and effort that must be made to get ready for instituting depreciation accounting. This preparatory work involves a long and detailed investigation of the various peculiar phases of depreciation accounting as applied to the railway industry and the assembly of a great amount of data, with consequent expense to the carriers. In addition much time will be required to carry out the provisions by the large carriers.

The second step is the current accounting methods which commence on a date to be prescribed by the Commission in the future. An entirely different organization and method of procedure is necessary for the current operation. The only similarity with the inaugural work is maintaining the depreciation base up to date, and a continuation of studies of service lives and values in order to be in a position to verify the correctness of composite percentage rates, and to be in position

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to make an application for a change when circumstances require it.

The Commission has now served Supplements No. 4 and No. 5 to Valuation Order No. 3, Second Revised Issue, and Valuation Order No. 25, on certain carriers which require the use of a new "List of Units," and the preparation and filing of B. V. Form No. 588 for bringing the basic valuation down to date; also requirements as to revision of the original accounting report. Certain of the work in connection with the preparation and filing of B. V. Form No. 588 is closely allied to the accounting process it is necessary to follow in the inaugural work of the depreciation order. It is important that consideration be given by carriers to avoid a duplication of effort handling these two tasks and to organize the depreciation work, or the work in connection with B. V. Form No. 588, to avoid unnecessary effort and expense.

The committee, in its study of the subject of depreciation accounting, has given consideration to the use of various forms and mechanical means that might be used to save much detailed accounting work. It is believed that much labor and time can be eliminated by the use of mechanical appliances.

After a complete study of the subject, the committee arrived at the following conclusions:

Conclusions

(1) The Order involves both engineering and accounting work and, as it is impracticable to segregate the work of each, compliance with the Order should be handled as a unit.

(2) To inaugurate and currently handle the requirements of the Order involves a radical revision of the mandatory accounting regulations heretofore in effect and imposes a large expense and burden upon carriers. It is the belief of the committee that the effect of depreciation accounting, as outlined in the Order, will result in further increased annual charges to carriers' operating expenses and that if the amount of past accrued depreciation, not accounted for, as required to be set up by the present Order, is cleared by a charge to profit and loss, in many instances, the profit and loss account of carriers will be entirely extinguished.

(3) It is impracticable to comply with the provisions prescribed for accounting for extraordinary repairs.

(4) The filing of an annual report of deferred maintenance, if any, is an impracticable and unnecessary provision.

(5) The committee believes that the Commission's orders, Supplement No. 4 and Supplement No. 5 to Valuation Order No. 3, Second Revised Issue, and Valuation Order No. 25, are closely related to the depreciation accounting scheme of the Commission as is set out in the Depreciation Order Docket No. 15100, and that the work of complying with these orders should be synchronized and co-ordinated to the fullest extent, although realizing that there are two separate bureaus of the Commission involved, having different viewpoints and purposes to accomplish.

Following a statement of its conclusions, the committee presented an exhibit, designated "A," which consisted of a suggested classification of property for the stating of a depreciation base, which may be used in complying with the Interstate Commerce Commission Depreciation Order, Docket No. 15100.

Appendix F—Reports for Maintenance Foremen Which Will Reduce the Number Required and Permit Uniformity, Simplicity and Economy

This report was presented as a continuation of a series of reports presented previously, with the idea that when progress reports are completed, all data gathered will be arranged and presented as a final report.

Following a summary of current practice on typical roads, with respect to material reports required from foremen, both daily and monthly, the committee stated that its tabulation indicated that the minimum requirements for a track foreman's daily material report are as follows:

Material Used	Material released
Location	Location
Description	Description
Quantity	Quantity
New	
Second hand	

In closing its report, the committtee continued as follows:

To meet these minimum requirements and to reduce, insofar as possible, the clerical work required of the foreman and supervisor (summarizing to be done in office of division engineer or division accountant), and to furnish such additional information as the committee thought necessary, the form included herein, marked Exhibit A, has been designed. On this

Form No.......

THE NORTH & SOUTH RAILROAD COMPANY

.......Northern.....Division

Sheet 1 of 3 Sheets of this form forwarded this date June 14 1924

Section or Gang Number 4

TRACK FOREMAN'S DAILY MATERIAL REPORT

Location York

Class of Work Extend team track 20 ft. A.F.E. #262

Material, Size and Kind 1	Unit 2	Quantity: Used: New 3	Quantity: Used: Usable 4	Quantity: Released: Usable 5	Quantity: Released: Scrap 6
1 Ties 6"x8"-8' Creo. Pine	each	12			
2 Rail 85# O.H. Relay	foot		40		
3 Angle bars 24" Oil treated	pair		2		
4 Bolts 7/8" x 4½"	each	8			
5 Nut locks	"	8			
6 Spikes 9/16" x 5½"	"	48			
7					
8					
9					
10					
11					
12					
13					
14					

Correct John Smith Foreman

Approved T. L. Gerry Supervisor

This report is to be forwarded to the Supervisor each day. If no material was used, a blank form should be sent stating that no material was used.

A separate report on this form is to be furnished for each class of work, Repairs to Passenger Tracks, Repairs to Freight Tracks, Repairs to Common Tracks, Repairs to I. & C. Tracks, New Work, etc.

Items of material must be fully described as shown on Record of Material on Hand.

Exhibit A—Track Foreman's Daily Material Report

form are included necessary instructions. The form as designed is 8½ in. by 11 in. in size and should be bound in pads of 100 sheets. The form may also be bound in book form with alternate sheets perforated, the perforated sheet to be forwarded each day to the supervisor and the sheets not perforated retained in book form and, if desired, forwarded at the end of the month, thus combining the advantages of the daily and monthly method of reporting material used.

Another question to be decided by the individual carrier is the comparative merits of having items of material printed on the daily report form as against leaving blank spaces for foremen to write in the items. Relative advantages would appear to depend somewhat on conditions on each separate road. However, it would seem that the use of a form with blank spaces would be more satisfactory as items of material used each day are ordinarily not of sufficient number to seriously burden the foremen in writing them in. Economy of form space is also an argument for use of blank spaces.

There is also the question of combining reports of material and labor. If combined, the daily report assists in detecting failure in reporting materials used or released and requires only one description of work.

Discussion

[The report was reviewed by Chairman J. H. Hande (B. & O.) and the entire report accepted without comment on any important point.]

The President: Mr. Campbell, have you any observations you wish to make before the committee is excused?

J. L. Campbell (N. W. P.): The thought occurred to me, and I presume it is a fact, that this committee

in its work has the benefit of the expert knowledge of the engineers of railways generally in regard to valuation matters.

Past President E. F. Wendt (Consulting Engineer): It seems to me unfortunate that a report such as has been presented by this committee receives so little discussion. This is one of the most outstanding reports that has ever been presented to this association. I wish to commend the committee, not only for the quality and thoroughness of its work, but for the extent to which the committee has gone in the field which is covered so incompletely by its title.

It seems to me that the committee should proceed to outline principles and methods which commend themselves to its good judgment, giving due consideration to the work of other organizations. The engineer has a peculiar field in which to work in reference to records, reports, accounts, and valuation. This committee is composed of eminent men who consider not only matters of valuation but the relation of the law, accounting and economics to this question, so that their recommendations are really a text book on the general subjects which they have covered in this report.

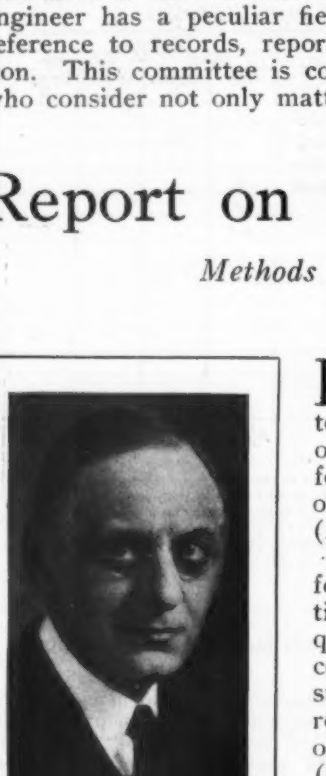
The report is an outstanding document. It shows the progress which is now being made in connection with some of the most important phases of railroading, such as the proper classification of accounts in the matter of the investment, the proper definition of depreciation, the correct application of the principles of depreciation to the accounting and the valuation, and many other subjects.

Before the year 1929 closes, the tentative order of depreciation which has been referred to by the chairman will be issued and then a great opportunity will be presented to the engineer to express his judgment as to the proper principles and methods which should be followed in determining one of the most important aspects of the whole railway work.

[The committee was excused with thanks.]

Report on Economics of Railway Location

Methods are presented for selecting electric locomotives and for applying cost data in studying line changes



F. R. Layng
Chairman

REPORTS were presented by the committee on (1) The economics of railway location as affected by the introduction of electric locomotives (Appendix A).

(2) Prepare in form for convenient use, essential operating data required for making relative comparisons of values for studies of line and grade revisions to meet modern operating requirements (Appendix B).

It recommended that Appendix A be approved for publication in the Manual, and that Appendix B be received as a progress report for information.

Appendix A—Economics of Railway Location as Affected by Electric Locomotives

Last year the committee pointed out the need of a method of determining the service performance of electric locomotives, particularly to answer the question which arises from time to time, "Shall the grade be revised, or shall the existing line be electrified?" This year the committee outlined in detail an approximate method for the selection of electric locomotives, which it felt was sufficiently accurate for a preliminary determination of the probable economy of electrification. Owing to insufficient space, only an outline of the method proposed by the committee is included in the following:

In choosing an electric locomotive to perform a specified service, the first step is to determine the weight required on its drivers. The governing factor may be either starting or running conditions on the ruling grade. Hence, it is necessary to find the weight on drivers for both starting and running and then use the larger value.

Following the presentation of formulas for determining the weight required on the drivers for both starting and running, the report stated that the next step is to find the capacity of the locomotive. Practically all electric locomotives can develop sufficient tractive effort to slip the drivers on sand, but this imposes an overload on the electrical equipment. The limit for the frequency and duration of overloads is in the heating of the electrical apparatus. In general the excess heat developed during the overloads produced by acceleration or short ruling grades may be stored temporarily and later dissipated under the easier running conditions. On long ruling grades it is unsafe to work the locomotive much above its rated continuous capacity.

The report then included a formula and detailed discussion of an approximation of the locomotive capacity for a particular ruling grade, and also included characteristic curves for the four general types of electric locomotives, to which reference was made in determining the relation between the speed and tractive effort of the various types.

The third main step described in the method outlined in the report was to determine the sufficiency of the locomotive, of the selected weight and capacity, to meet the required schedules, and the last step in the method was pointed out as being the determination of the quantity of electrical energy which must be delivered to the locomotive to perform the required service.

At the close of its report, the committee made the following statement:

The methods and data outlined in this report for the selection of electric locomotives are approximate. However, the results obtained by their use will be

sufficiently accurate for a preliminary determination regarding the probable economy of electrification. If such preliminary study indicates that electrification promises the best solution of the problem, a more accurate final study should be made by engineers specially trained in the application of electricity to traction.

Appendix B—Operating Data for Making Relative Comparisons of Values for Studies of Line and Grade Revisions

In previous years, the committee has published in the Manual of 1921, pages 800 to 817, inclusive, and in the supplements thereto, principles to be followed in the solution of railway location problems involving initial locations, as well as revision of lines that are being operated. This matter has been discussed in considerable detail in the Proceedings of the association.

This year the committee suggested a short-cut method of obtaining and applying cost data in making studies of this character, and while space does not permit the presentation of this method here in full, the following abstracts from the report will give an idea of the work undertaken by the committee, and the character of the formula which it proposed.

In order to determine the relative economic value of the line after the proposed improvements in alinement and grade have been constructed, compared with the operated line, it is necessary to determine the relative out-of-pocket operating cost. The savings in out-of-pocket operating costs, in relation to the cost of the proposed improvements chargeable to additions and betterments, will be the measure of the economic value of the improvements and this will largely depend on the volume of business to be handled and the physical characteristics of the operated line, compared with the proposed revised line.

A practical formula for making relative comparisons of values for studies of line and grade revisions should include as large a portion of the direct expense of operating train service as possible. The value of such a formula is greatly enhanced by the simplicity and ease with which it may be applied. Such a formula is now being used on some roads to advantage; its application involves very little expense and train service costs are developed which enable reasonably accurate economic comparisons of handling traffic by various routes or by handling traffic over the proposed line and grades compared with the existing facilities that are being operated. In this formula the train hour is taken as the most appropriate unit of service and the principle is adopted that the cost per train hour, excluding wages, will vary in direct proportion to the tractive power of the locomotive used and the number of locomotives per train, or, more precisely, the ratio of locomotive miles to train miles.

It may be said that some of the elements of train service costs do not in fact vary in direct proportion to the train hours; that fuel and locomotive repairs per train hour, for example, will be greater if the train speed is 18 m.p.h. than if, under the same conditions as to grades and train loads, the train speed is 9 m.p.h., such difference in the train speed being due, in this case, to interference of other trains.

Wherever extreme fluctuations in train speed enter into the problem special consideration should be given to the effect of such changes upon the unit cost per train hour. Sometimes it is feasible to do this by comparing unit costs on several existing lines with varying train speeds where all of the conditions are known, but in making such studies it is highly important to examine the method used in recording and distributing the basic cost data. They may not represent facts.

The unit cost per train hour embraces:

Wages of train and enginemen
Fuel and water for locomotives.
Lubricants and other supplies for locomotives.
Enginehouse expenses.
Train supplies and expenses.
Locomotive repairs.
Locomotive depreciation and retirements.
Interest on locomotive investment.

In addition to the train hour cost as above defined, the formula provides for the inclusion, when applicable, of the following:

Maintenance of Way.
Equipment Rental—Per Diem.

These items represent approximately 80 per cent of the total maintenance and transportation expenses, which vary with the volume of traffic.

In the application of the formula for determining the relative out-of-pocket operating cost the following information concerning the present line is essential:

(1) Distance between terminals—miles.
(2) Ruling grade in each direction—length in miles and rate of grade.
(3) Helper grade in each direction—length in miles and rate of grade.
(4) Number of freight trains of each class in each direction, such as local, manifest and slow freight.
(5) Wages of freight train and enginemen in each class of service in each direction.
(6) Wages of helper crews, in each direction.
(7) Freight train miles for each class of service in each direction, excluding train switching miles.
(8) Principal locomotive miles in each class of service in each direction, excluding train switching locomotive miles.
(9) Helper locomotive miles, including the return light helper miles, in each direction.
(10) Rating gross ton miles in each class of service in each direction.
(11) Actual gross ton miles in each class of service in each direction.
(12) Train hours in each class of service in each direction.
(13) Train speed (miles per hour) between terminals in each class of service in each direction.
(14) Average tractive power of locomotives in each class of freight service.
(15) Annual Maintenance of Way expenses.

For the line after the proposed improvements have been constructed it will be necessary to determine similar data cover-

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*Died November 14, 1928.

ing the proposed operation for each of the above items for individual trips in each direction and for handling a given volume of business.

Among the many factors that affect the cost per train hour the most important are the size of the locomotive and the ratio of locomotive miles to train miles. Usually the same classes of locomotives will be used after the completion of the line and grade revision as are operated on existing facilities but in the event the proposed changes in the physical conditions permit the operation of a different size of motive power, the formula provides for adjustment of the train hour cost. If new locomotives be substituted for old, the formula gives effect to the interest upon the difference between the cost of the new locomotive and the depreciated value of the old one. The formula, however, does not and cannot make allowance for changes in type of locomotives used. If, in a given case, modern locomotives equipped with super-heaters, feed water heaters, boosters, or with tanks of greater capacity are to be substituted for older types not so equipped, that substitution presents a problem with which the committee is not here concerned, but in such a case it would be necessary, in order to estimate the economic value of the proposed road improvements, to assume either.

(a) That the existing motive power will be used after the improvements are completed, or

(b) That the proposed new locomotives will be used on the existing line before the proposed road improvements are undertaken.

The latter assumption is the safest because it will ordinarily tend to reduce the savings which can be attributed to the proposed road improvement.

It is necessary to determine the actual cost per train hour on the particular district under consideration in order to compute the cost of handling a given volume of traffic with the existing facilities. This is accomplished by using the simple formula, (1) $C_t = C_h \times H$ in which:

C_t = Total cost of handling a given volume of traffiic.
C_h = Cost per train hour.
H = Number of train hours.

This equation is used in developing the cost of train service on the existing line of railroad compared with what the cost should be after the proposed improvements in line and grade have been constructed.

Following this part of its report, the committee showed in detail how the data necessary in the application of its formula can be obtained and compiled for use. It also presented an example showing the application of the formula in which it is desired to know the cost of train service of moving a given volume of traffic between points "A" and "B" on a railroad, compared with the probable cost of moving the same traffic between the same points after certain line, grade and track revisions have been made.

Following the report proper, the committee included two exhibits. Exhibit A was a demonstration of the use in actual practice of the formula outlined in the report, and contained the computation of the out-of-pocket cost of assembling and hauling coal on the Chesapeake and Ohio from the Kanawha and Eastern Kentucky district to Newsport News, Va. Exhibit B was copied from an exhibit in Financial Docket No. 4818, submitted by the Chesapeake & Ohio in a hearing before the Interstate Commerce Commission. This exhibit presented a comparison of the out-of-pocket cost of existing routes with the estimated out-of-pocket cost over a proposed route in which it was assumed that the same motive power would be used over both routes.

Supplementing the report and the two exhibits, there was presented a discussion of the report by C. P. Howard, a member of the committee, who objected to the methods suggested by the committee. In the opening sentence of his discussion Mr. Howard said: "It presents a short-cut formula which is a statistical rather than an engineering solution of the problem, ignoring physical differences between lines except the rate of ruling grade and length of line."

A written dissenting opinion concerning the report was also presented by W. L. R. Haines, a member of the committee, who made the general statement in introducing his discussion, that "No 'short-cut' method can be expected to fully take the place of a detailed analysis, the first step in which should be the preparation of a 'speed-time' profile."

Discussion

[The report was introduced by Chairman F. R. Layng (B. & L. E.), who called upon Subcommittee Chairman F. E. Wynne (Westinghouse Elec. & Mfg. Co.) to present the report on the economics of railway location as affected by the introduction of electric locomotives. After calling attention to the application of the various clauses, Mr. Wynne withdrew his recommendation that the report be approved for publication in the Manual and concurred with the recommendation of the Committee on Electricity, with which this committee collaborated, that the report be referred to the Joint Committee on Electric Traction.

The report on the preparation in form for convenient use of essential operating data required for making comparisons for studies of line and grade revision was presented as information by Subcommittee Chairman R. S. Marshall (C. & O.), who stated that the data were given simply as a progress report and that further studies of the subject would be made. The committee was then excused with the thanks of the association.]

Remote-Power Switch Machine and Hand Crank Stand at Siding on the Texas & Pacific

Report of the Committee on Buildings

New specifications presented covering ornamental metal work, brick pavements and floors, and sprinkler systems

F. R. Judd
Chairman

THE reports presented by the committee are as follows:

(1) Revision of Manual (Appendix A).

(2) Specifications for concrete used in railway buildings, collaborating with the Committee on Masonry (Appendix B).

(3) Collaborate with the Committtee on Rules and Organization in the study of rules and regulations for employees of the buildings department (Appendix C).

(4) Design and construction of water station buildings, collaborating with the Committee on Water Service (Appendix D).

(5) Specifications for buildings for railway purposes (Appendix E).

(6) What constitutes appraisal of fire losses (Appendix F).

The committee recommended: That the changes in the Manual suggested in Appendix A be approved; that the subjects of Appendices B and D be reassigned; that the subject of Appendix C be discontinued; that the specifications published in Appendix H, pages 939 to 965 of Bulletin 304, Vol. 29, for the 1928 convention, be approved for publication in the Manual and that the specifications published in Appendix E of this report be received as information; and that Appendix F be received as a progress report. The committee also recommended that the two following subjects be assigned to it:

(a) Prepare recommended clearance diagrams for both main and subsidiary tracks adjacent to or entering building structures.

(b) Waterproofing and dampproofing as applied to building construction.

Appendix A—Revision of the Manual

The committee reported that all of the subject-matter included in the 1921 Manual had been checked during the last few years, and after listing the changes which have been made from time to time, said the following with regard to changes in Subject 15, Specifications for buildings for railway purposes:

Section 5. Brickwork.—It is recommended that the last sentence in Article 3 be revised to read: "Porous or salmon brick shall be thoroughly wetted either by immersion or sprinkling before being laid, except in freezing weather."

It is further recommended that this sentence be repeated at the end of Article 4. It is recommended also that Article 7 be changed to read: "Cement: The cement shall meet the requirements of the American Railway Engineering Association's Specifications for Portland Cement. Cement that has hardened or partially set shall not be used."

Section 6. Stone Masonry and Cut Stone.—It is recommended that beginning with the next to last sentence in Article 7, the text be changed to read: "The cement shall meet the requirements of the American Railway Engineering Association's specifications for portland cement. Cement that has hardened or partially set shall not be used.

"Sand shall be clean, sharp, coarse and of grains varying in size. It shall be free from sticks or other foreign matter, but it may contain clay or loam not to exceed two per cent. Where so required for pointing face work, sand shall be clean, sharp, white sand of the very best quality.

"Lime used shall be of good quality, in large lumps, free from cinders, or clinkers, must contain less than ten per cent impurities and must slake readily in water, making a very soft paste, free from core. Before being used all lime shall be thoroughly slaked with water. No air slaked lime shall be used. The use of hydrated lime of approved brand will be permitted at the discretion of the engineer."

Section 12. Structural Steel and Iron.—It is desired to change the number to Section 12-A in view of adding another section 12-B covering ornamental and miscellaneous metal work.

Section 12. Carpentry and Mill Work.—It is suggested that a sentence be added to Article 20 reading: "All glass and glazing shall conform to Section 16, Painting and Glazing, Articles 24 and 26." It is also suggested that the third sentence of Article 14 be changed to read: "Treads shall have molded nosings, be ploughed into risers and risers into the underside of the treads, and both housed into the wall stringer, tightly wedged and glued."

Section 15. Marble and Tile Work.—It is suggested that an additional paragraph be added to Article 9—Terrazzo, to read as follows: "Contractor shall submit finished samples not less than six inches square showing the color and finish for the engineer's approval before work is started."

Section 16. Painting and Glazing.—It is suggested that Article 13 be changed to read as follows: "Where enameled finishes are called for on wood or plastered surfaces, these surfaces shall be given three coats of flat white, each of which shall be lightly sandpapered before the succeeding coat is applied, and shall then be given two coats of approved enamel applied in accordance with the manufacturer's instructions."

Appendix B—Specifications for Concrete Used in Railway Buildings

In view of the recent developments in the practice of construction in concrete, the committee prepared an entirely new draft of its specifications. This draft has been discussed by the Committee on Buildings and certain corrections were suggested, but the final draft was not completed in time for proper collaboration with the committee on Masonry. Therefore the specification was not submitted to the association this year.

Appendix C—Rules and Regulations for Employees of the Buildings Department

The work of the committee on this subject culminated in the formation of a set of rules, which were submitted to the Committee on Rules and Organization. The rules are included in the report of the latter committee and recommended for inclusion in the Manual.

Appendix D—Design and Construction of Water Station Buildings

The committee reported that it had prepared a tentative final report on the design and construction of water station buildings, together with recommendations and conclusions, but was not ready to submit the report since final action on it had not been taken by the committee as a whole.

Appendix E—Specifications for Railway Buildings

Without reproducing them in its report, the committee sought the approval for publication in the Manual, of the specifications published in Appendix H, pages 939 to 965 of Bulletin 304, Vol. 29, 1928.

The specifications are: Section 22, Concrete paving; 23-A, Wood block paving; 23-B Wood block flooring; No. 25-A, Asphalt block paving; 25-B, Asphalt block flooring; 26-A, Macadam paving, and 26-B, Asphalt macadam paving.

In addition, the committee offered tentative specifications covering Section 12-B, Ornamental and Miscellaneous metal work; Section 21, Brick paving and flooring; and Section 21, Sprinkler systems. Parts of these specifications are included in the following paragraphs.

Ornamental and Miscellaneous Metal Work

(1) *General.*—The contractor shall furnish all labor, material, tools and equipment necessary to entirely complete the ornamental and miscellaneous steel, iron, bronze, brass or other similar metal work as herein specified and as called for on the drawings.

(4) *Steel.*—Rolled steel shall be made by the open-hearth process and otherwise shall comply with the "Standard Specifications for Structural Steel for Buildings" of the American Society for Testing Materials, Serial Designation A-9.

Cast steel shall be in accordance with the "Standard Specifications for Steel Castings," Class "B" of the American Society for Testing Materials, Serial Designation A-27.

Where copper-bearing steel is specified, it shall contain not less than two-tenths per cent.

(5) *Wrought Iron.*—Wrought iron shall comply with the "Standard Specifications for Refined Wrought Iron Bars" of the American Society for Testing Materials, Serial Designation A-41.

(6) *Cast Iron.*—Cast iron shall comply with the "Standard Specifications for Gray Iron Castings" of the American Society for Testing Materials, Serial Designation A-48.

(7) *Miscellaneous Metals.*—Non-ferrous metals and alloys of ferrous and non-ferrous nature shall comply with the current specifications of the American Society for Testing Materials.

Bronze castings shall be made from a standard bronze metal adapted to fine castings. Sheet bronze shall be rolled bronze plate and shall match cast bronze in color.

(11) *Wrought Iron Fences.*—Where shown on drawings, fences shall be made of wrought iron. Wrought iron fences may be either hot or cold riveted or welded. Posts shall be set not less than three feet deep into bell shaped concrete footings shaped at the top to shed water and affording a minimum covering of two inches over the metal. Posts shall be thoroughly braced or stayed transversely with the line of the fence. Fences shall be designed to withstand a horizontal pressure of not less than 25 lb. per sq. ft.

(12) *Stairs, Balconies and Ladders.*—Stairs and balconies shall be designed for a live load of 100 lb. per sq. ft. Ladders shall be designed for a live load of 300 lb. upon each rung. Stairs shall be equipped with an approved anti-slip tread. Spiral stairs will not be permitted unless specifically authorized by the engineer.

(13) *Fire Escapes.*—Fire escapes shall comply with local laws and ordinances but shall be designed for a live load of not less than 100 lb. per sq. ft. Fire escapes shall also comply with the requirements of the National Board of Fire Underwriters. Railing shall be able to withstand a horizontal pressure of 50 lb. per lin. ft.

(18) *Metal Frames for Doors and Windows.*—Metal frames for doors and windows shall match the metal doors and sash to be fitted into them and shall be of the same type and style. Frames shall be equipped with suitable anchors and bolts to fasten them to walls and structural parts of building and to make a watertight joint. Contractor shall furnish details of metal frames for approval.

(19) *Metal Doors and Fire Doors.*—Metal doors may be either swinging, rolling or sliding and of solid or hollow sections. Doors shall be so counterweighted and balanced that they may easily be operated by one man. No metal shall be less than No. 22 U. S. standard gage and if of steel shall be copper bearing.

Doors shall be complete with track, hangers, bumpers, counterweights, stops, stay rollers, door pulls, locks and chafe and binder strips.

Doors shall be stiff enough to resist bending and warping and when of hollow section shall be absolutely watertight to prevent internal corrosion.

Fire doors shall meet all the requirements specified above for metal doors and shall meet the requirements of the National Board of Fire Underwriters for particular use intended.

(21) *Metal Sash.*—Metal sash may be either solid or hollow section as indicated on drawings. No metal shall be less than No. 22 U. S. Standard gage and if steel, shall be copper-bearing. The type of sash and section shall be acceptable to the engineer and the sash shall be of such sizes and units as are shown on drawings. Ventilators shall be located where shown on drawings. The manufacturer of the cash shall furnish and supervise the erection of the operators as well as the sash itself. Metal sash shall be equipped with necessary attachments for window cleaners' hooks both inside and outside of building.

(25) *Treads and Thresholds.*—All treads and thresholds and edges of landings shall have a type of a non-slip or safety surface. Treads and thresholds shall be equipped with suitable anchors and where exposed to moisture shall be composed of copper bearing steel or other corrosive resisting metal.

(27) *Ventilators and Smoke Jacks.*—Metal smoke jacks for enginehouses and ventilators for blacksmith shops and similar buildings shall be cast iron. Ventilators and smoke jacks shall be provided with dampers which can be operated from the floor.

(28) *Coal and Ash Doors and Hoppers.*—Coal and ash doors and hoppers and their frames shall be of heavy cast iron. When entering buildings, the doors shall be provided with suitable latches on the inside.

(30) *Metal Ceilings.*—Metal ceilings shall meet the approval of the engineer. Contractor shall submit detail drawings showing design, thickness of metal, supports and weights in detail. On steel buildings, concrete buildings or other fireproof structures metal supports shall be used.

(31) *Metal Partitions.*—Metal partitions for toilets, shower baths and in other locations where subjected to moisture shall be of corrosive resistant metal. Partitions shall be installed complete in place, including all hardware, glazing and painting. Detail drawings shall be submitted to the engineer for approval before ordering.

(33) *Painting.*—Unless otherwise specified all steel and iron work shall receive one coat of approved paint in the shop and two field coats, as specified in Section 16 of these specifications covering Painting and Glazing. Office and other metal partitions shall have hard baker enamel finish of such colors as the engineer directs.

Brick Pavements and Floors

(1) *General (Pavements and Floors).*—The contractor shall furnish all labor, material, tools and equipment, except as otherwise noted, necessary to entirely complete the work as specified and as shown or implied on the drawings.

(2) *Description (Pavements and Floors).*—The work shall

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consist of a subgrade, a concrete foundation and a vitrified paving brick wearing surface laid over a cushion of either bituminous mastic, cement mortar or sand.

(3) *Grading, Subgrade and Foundation (Pavements).*—The grading, subgrade and concrete foundation shall be constructed in accordance with the current specifications of the A. R. E. A. for concrete pavements, except that joints shall be omitted and the concrete finished to a smooth even surface exactly the depth below the finished pavement, corresponding to the combined depth of the paving brick and the bituminous mastic, cement mortar or sand cushion.

(3) *Subgrade and Foundation (Floors).*—The subgrade, if one be needed, and the foundation shall be designed of sufficient strength to carry the loading to be encountered, and shall be constructed in accordance with the current specifications of the A. R. E. A. for concrete for railway buildings as given in Section 4 of these specifications, except that the concrete shall be finished to a smooth, even surface, with no projection of any kind, parallel to the contour of and exactly the depth below the finished floor level, corresponding to the combined depth of the brick and the thickness of the bituminous mastic, cement mortar or sand cushion.

(5) *Paving Brick (Pavements and Floors).*—Paving brick shall comply with the requirements of the current Standard Specifications for paving brick of the American Society for Testing Materials, Serial Designation C-7.

Brick shall be vitrified and evenly burned, thoroughly annealed, tough and free from lime, air pockets, cracks or marked laminations. Kiln marks must not exceed $\frac{3}{16}$ in. and one edge at least shall show but slight kiln marks. Brick so distorted as to lay unevenly in the work will be rejected.

The standard size of vitrified paving block shall be 3½ in. in thickness, 4 in. in depth, and 8½ in. in length. The brick shall have one reasonably straight face and shall not vary from these dimensions more than ⅛ in. in width or depth, nor more than ½ in. in length. If the edges of the brick are rounded, the radius shall not exceed $\frac{3}{16}$ in.

The brick shall not lose more than 20 per cent of their original weight when subjected to the rattler test.

Brick shall be subject to thorough inspection before and after laying and rolling and all rejected material shall be immediately removed from the work.

The contractor must submit with his proposal, a sample of the paving brick which he proposes to use, for approval by the engineer. All brick used must be equal to the approved sample.

(9) *Expansion Joints (Pavements).*—When cement grout filler is used, an expansion joint of bituminous material shall be placed parallel with and adjacent to the curb line or tracks, around all obstructions in the paving, transversely across the paving points of change in grade or alignment and at the points of curvature of the curb line at all intersecting pavements.

The bituminous filler for the expansion joints shall consist of a mixture of 65 per cent asphalt filler, 15 per cent coal tar pitch filler and 20 per cent Portland cement.

(9) *Expansion Joints (Floors).*—When cement grout filler is used, an expansion joint of bituminous material shall be placed around the walls and columns and all other obstructions in the flooring.

The bituminous filler for the expansion joints shall consist of a mixture of 65 per cent asphalt filler, 15 per cent coal tar pitch filler and 20 per cent Portland cement.

(11) *Laying Paving Brick (Pavements).*—The pavement shall be laid upon the above specified bituminous mastic, cement mortar or sand cushion in a single layer of brick on edge, end to end and at right angles to the center line of the thoroughfare except at intersections where the courses shall be laid at such angles as the engineer directs. All brick paving and conveying of brick shall take place over brick already laid and shall follow the completion of the cushion within 50 ft. The better face or wire cut side shall be laid up and lugs, if any, shall be turned in one direction. Alternate courses shall begin with one-half a brick and where necessary shall be completed by batting at the ends with bats not less than three inches long, a portion of the adjoining brick being broken off if necessary to give the minimum three-inch bat at the end of the course. The fractured end of cut or trimmed brick shall be turned toward the center of the pavement. Every course shall be laid true and even, perpendicular to the center line of the pavement and no course shall deviate from a straight line more than two inches in 30 ft. The bricks in adjacent courses shall break joints at least two inches. The contractor may be required to lay every tenth course to a line. The bricks shall be set perpendicular to the grade and to a height from ¼ in. to ¾ in. or such other height as the engineer may direct above the true finished grade of the pavement to provide settlement in tamping and rolling.

When the curvature of the alignment of the pavement permits, the brick shall be laid in radial courses allowing at the outside of the curve a space between courses not exceeding ½ in. When the curvature exceeds this, the brick shall be laid in radial courses transversely across the roadway and in the intervening space between the courses the brick shall be laid longitudinally at right angles to one of the transverse courses of each successive closure. No portion of a brick less than three inches in length shall be used for batting such closures and the amount of space batted shall not exceed a whole brick, by varying the length of the successive transverse courses. In no case shall brick be split longitudinally to make a closure on a curve.

(11) *Laying Flooring Brick (Floors).*—The flooring brick shall be laid upon the above specified bituminous mastic, cement mortar or sand cushion in a single layer of brick on edge, end to end and at right angles to the center line or axis of the building. All brick laying and conveying of brick shall take place over brick already laid and shall follow the completion of the cushion within 50 ft. The better face or wire cut side shall be laid up and lugs, if any, shall be turned in one direction. Alternate courses shall begin with one-half a brick and where necessary shall be completed by batting at the ends with bats not less than three inches long, a portion of the adjoining brick being broken off, if necessary, to give the minimum three-inch bat at the end of the course. The fractured end of cut or trimmed brick shall be turned toward the center axis of the building. Every course shall be laid true and even, perpendicular to the axis of the building and no course shall deviate from a straight line more than ½ in. in 10 ft. The bricks in adjacent courses shall break joints at least two inches. The contractor may be required to lay every tenth course to a line. The brick shall be set perpendicular to the grade and to a height from ¼ in. to ¾ in. or such other height as the engineer may direct above the true finished grade of the floor to provide settlement in tamping and rolling.

(16) *Adjusting Existing Structures (Pavements).*—Manholes and catchbasin covers, valve boxes and similar existing structures within the area to be paved shall be adjusted by the contractor to come flush with the pavement surface.

Sprinkler System

Dry Pipe, Wet Pipe or Deluge System

(1) *General.*—Sprinkler system to be installed under this contract shall consist of the furnishing and installing of a sprinkler system complete as herein described.

(4) *System.*—The sprinkler system to be used will consist of what is known as a dry pipe system, wet pipe system or deluge system, same to be designed and installed in accordance with the rules and regulations of the Underwriters having jurisdiction in territory in which the sprinkler system is to be installed.

(5) *Piping System.*—The system of piping shall be best suited to the building in which the sprinkler system is to be installed.

If it is necessary to divide the sprinkler system into a number of sections, each section shall be provided with an indicating control valve to be situated in suitable location. Each section shall also be provided with drains to enable the sections to be drained if found necessary. The ends of piping *must* be reamed in order to remove burrs and fins, also the threads on the piping shall be cut to provide a good joint. The piping shall not extend into the fittings to such an extent as to restrict the flow of water. Piping shall be made up in place. The assembly of piping on the ground prior to its being hung will not be allowed on account of the possibility of straining fittings. Piping shall be straight, and contractor will be required to replace any piping that is likely to cause any pockets. Connections to supply mains are not to be made until contractor has flushed out supply main, and is assured that there is no foreign matter in the line that may cause any stoppage or foul in sprinkler heads.

(7) *Control and Drain Valves.*—Control valves in the system shall be of the outside screw and yoke type gate valve of proper weight to withstand the water pressure to be carried on the system. Drain valves in system shall be gate type of proper weight and design to withstand water pressure carried on system. Each valve shall be plainly marked to designate service.

(8) *Automatic Control Valves.*—Automatic control valve or valves for the dry pipe system, wet pipe system, or deluge system shall be installed in a suitable and accessible location in the building. If it is necessary to install the valve or valves in location where the temperature will fall below 32 deg. Fahr., necessary precautions shall be taken to frost-proof all equipment exposed to low temperatures.

(10) *Sprinkler Heads.*—Sprinkler heads used in this installation shall be constructed for the temperature best suited for the protection of the building. They shall be of the soldered link or quartz bulb type. They shall not be installed until the piping is installed in place. Sprinkler heads shall be applied with special wrenches provided by the manufacturer, and the contractor shall use every precaution against damaging the sprinkler heads during installation. Sprinkler heads shall be provided with guards wherever necessary. Cabinet with extra sprinkler heads and special wrenches shall be provided in accordance with Underwriters' requirements.

(11) *Source of Water Supply.*—The water to be used in sprinkler system shall be obtained from underground mains, house tank or elevated tank, and the contractor shall make the necessary connection or connections to source of supply where indicated on drawings. Contractor shall install at each point where connection is made an indicating outside screw and yoke type gate valve. He shall also provide necessary test connection, strainers, check valves, clean-out and flushing connections, etc., required by the Underwriters.

(16) *Fire Department Connections.*—Fire department connection shall be provided if specified. This connection shall be of required size and conform to the requirements of the Underwriters.

(21) *Guarantee.*—Contractor must guarantee the perfect operation of the system heretofore described that it will be capable of fulfilling the requirements of the Underwriters having jurisdiction. Any omission in these specifications or the drawings accompanying same do not relieve the contractor of fulfilling his obligations to install the system complete in every respect, and fulfill his guarantee.

Appendix F—Appraisal of Fire Losses

The committee reported that a questionnaire was sent to all roads represented by the Association. So far replies have been received from 52 roads. Of the replies, some 30 roads are covered wholly or in part by outside insurance companies, 33 wholly or in part by insurance funds of their own, and six are protected by mutual companies.

The committee expressed the hope that further replies to the questionnaire will be received so that it can make a complete formula of the results and establish definite recommendations.

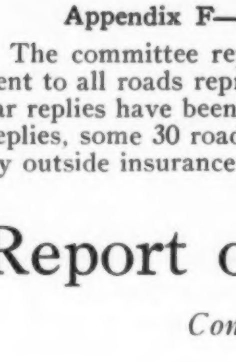
Discussion

[The report was introduced by Chairman Frank R. Judd (I. C.), who called upon Subcommittee Chairman A. L. Sparks (M.-K.-T.) to present that part of the report concerning the revision of the Manual. Mr. Sparks called attention to the various proposed changes in the Specifications for Buildings, which were of an editorial nature to clarify and simplify the subject matter without in any way changing the intent of the specifications. *His motion to approve these revisions of the Manual was carried.*

In the absence of Subcommitte Chairman J. W. Orrock (C. P. R.), Chairman Judd presented specifications for concrete paving, wood block paving, wood block flooring, asphalt block paving, asphalt block flooring, macadam paving and asphalt macadam paving, and *his motion that they be approved for publication in the Manual was carried.* He then presented as information three new specifications: Ornamental and miscellaneous metal work, brick paving and flooring, and sprinkler systems, with the request that they be considered by members of the association so that they may be presented at the 1930 convention for approval for publication in the Manual.]

Report on Economics of Railway Operation

Committee gives extended study to ways of increasing capacity of tracks, and to the effect of large engine tenders



J. M. Farrin
Chairman

The committee reported on the following subjects:

(1) Revision of the Manual.

(2) Methods for obtaining more intensive use of existing railway facilities, with particular reference to increasing carrying capacity: (a) Without material capital expenditures; (b) With due regard to reasonable capital expenditures consistent with traffic requirements. (Appendix A).

(3) Methods for formulas for the solution of special problems relating to more economical and efficient railway operation (Appendix B).

(4) The most economical make-up of track to carry various traffic densities, collaborating with Committee on Rail (Appendix C).

(5) Suitable units for operating and equipment statistics required by Interstate Commerce Commission to be used in cost comparisons of transportation, equipment and roadway maintenance, with necessary additions thereto, collaborating with the Committee on Records and Accounts, and the Committee on Economics of Railway Labor (Appendix D).

(6) What volume or other conditions of business or service justify a change from flat switching to the hump method in any given yard, collaborating with the Committee on Yards and Terminals (Appendix E).

(7) Problems of railway operation as affected by the introduction of motor trucks and bus lines, with particular reference to their effect upon branch or feeder lines, collaborating with the Motor Transport Division, American Railway Association (Appendix F).

(8) Most economical train length, considering all factors entering into transportation costs, such as fuel, road time, length of passing sidings, per diem, etc. (Appendix G).

(9) Economics resulting from the use of radio telephones for long freight trains and for yard work.

The committee recommended that no changes be made in the Manual this year; that the report in Appendix A be received as a method of arriving at operating economies realized both with and without capital expenditure; that Appendices B and E be received as information and the subjects reassigned; that Appendices D, G and F be received as progress reports and the subjects reassigned; and that Appendix C be received as information and work be held in abeyance until the similar subject is reported by the Rail Committee.

Appendix A—More Intensive Use of Existing Railway Facilities

This year, the committee studied and reported on the two new subjects which it felt fell within the scope of its assignment. These two subjects were: (1) Study and develop methods for determining most economical train lengths, considering all factors entering into transportation costs, such as fuel, road time, length of passing sidings, per diem, etc., and (2) study effects of improvement made on a heavy traffic North and South railroad.

On account of the technical character of these studies they were presented as Exhibits A and B, the committee stated that those interested in making similar investigations on other roads will find these studies helpful guides in planning their work.

Data for making the study in Exhibit A were obtained from a road in the Western district, consisting of seven operating districts. For the most part the road traverses a rolling country calling for grades of 0.5 per cent or less. Near the north end there is a grade equivalent to 1.52 per cent ruling which requires helper service for a distance of nearly six miles.

The procedure proposed by the committee for making the study was as follows:

(1) Determine the track capacity for the given arrangement of tracks.
(2) Determine capacity of locomotives.
(3) Show how track and locomotive capacities combine.
(4) Simplify train-hour diagrams by constructing the corresponding freight train performance charts.
(5) Determine the weight of train which will give the best performance.
(6) Compare performance with available track capacity.
(7) Compare performance with number of locomotives required.
(8) Compare performance with locomotive maintenance.
(9) Compare performance with fuel consumption.
(10) Compare performance with crew expense.
(11) Compare performance with other items of expense.

Following this order of procedure the committee made a careful analytical analysis of the particular road in question.

Exhibit A was arranged primarily as an example to be used for reference and to illustrate how the train-hour diagrams and freight-train performance charts may be used to bring out some of the fundamental factors which have to do with train operation. The committee stated that when these train performance studies are completed, and the facts are all assembled, the proper remedies can be applied as conditions warrant.

Exhibit B presented a study of the results effected by a heavy-traffic North and South railway through the construction of second track and a certain amount of grade reduction. This road, which operates 345 miles of lines, is divided into three operating divisions, of which the Northern division, with 122 miles, is the most important as a traffic carrier.

Freight traffic increased 60 per cent on the Northern division from 1921 to 1924. In 1924, 43 miles of this division were double tracked and 79 miles were single track. As the traffic was quite dense, slow freight train movement and excessive overtime resulted. Relief was necessary in order to take care of increasing business.

To obtain this relief, 58 miles of second track were added, making a total of 101 miles of double track. The effect of this improvement is shown by a comparison of train operations in June, 1924, and June, 1926, supplemented by figures for June, 1927.

Traffic density on the Northern division, measured by both the number of freight trains run, and the number of gross ton miles, showed a decided increase in June, 1926, over June, 1924, and June, 1927, shows a further increase over June, 1926, of about 10 per cent. The average road time of freight trains was lowered approximately 25 per cent over the three-year period. Gross ton miles per train hour increased approximately 50 per cent over the three years.

In addition to the increased efficiency that has resulted from the extension of the double track, the track capacity between engine terminals has been increased to practically double.

After presenting a discussion of all of the more important operating characteristics of this road, the committee stated the following in conclusion:

Conclusion

Our analysis shows that the construction of double track, along with the slight grade reductions made, practically doubled the capacity of the railway. All the increased capacity did not result from the additional track, as the grade reductions made possible an increase in loading. This increased capacity made it possible for the railway to accept all the tonnage offered and to handle same more efficiently than before double track was installed. The increase of 55 per cent in gross ton-miles per crew-hour will result in operating economies that justify the expenditures necessary to obtain this increased capacity.

In addition to those sections of the report presented in Exhibits A and B, the committee gave considerable

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attention to the subject of "Improved Service," which it felt was a matter of considerable importance.

Appendix B—Formulas for the Solution of Special Problems Relating to More Economical and Efficient Operation

The special problem assigned to the committee for the current year was to study the effect of the increasing capacity of engine tenders on the economical spacing of water stations and the cost of railway operation. Sections of the committee's report are given in the following:

Gross ton-miles per train-hour is recognized as one of the most significant units in operating statistics and is a comprehensive index of freight-train efficiency. An increase in gross ton-miles per train-hour may be brought about by:

(1) Increasing the train load without effecting a decrease in the average speed of trains between terminals.

(2) Accelerate the train movement between terminals by eliminating stops or by increasing the speed.

Freight-train stops for water and fuel materially contribute to increasing the average time of trains between terminals and consequently to increasing the cost of train operation. Some of the items that contribute to increasing the cost of train operation because of water and fuel stops are:

(a) Wages when on overtime basis.

(b) Loss of fuel and water (1) in generating power for brakes and (2) in overcoming additional train resistance while accelerating to the original speed; in addition, the fuel lost while at stop.

(c) Wear and tear on train equipment—both locomotives and cars.

(d) Unnecessary lubrication by enginemen when at stop. Forced lubrication and drip cups will not usually be stopped when train is not in motion.

(e) Equipment rental or per diem. As the car delays increase that item of expense accrues to foreign equipment and it is reflected in decreased car utility of owned cars.

(f) Decreases utilization of locomotives with corresponding increase in investment required to handle a given volume of business.

(g) Increases the cost of locomotive and train supplies and expenses.

(h) Increases the cost of enginehouse expenses because of increased engine time between terminals. The same work can be performed with a less number of engines and consequently a smaller enginehouse force.

(i) Damage to lading account of rough handling.

(j) Delays to following freight trains.

(k) Greater cost of water and fuel handling at small installations as compared with large efficient terminal plants.

It is not practical to state all costs that result from water stops, as a number of them are intangible and may vary between wide ranges, depending upon local operating conditions and traffic density.

Delays to heavy tonnage freight trains at water and fuel stations embrace:

(a) Time required to decelrate and accelerate to the original speed.

(b) Time at stop taking water and/or fuel.

(c) Time required to cut-off engine (when necessary) in order to stop at water and fuel stations.

(d) Time often necessary to cut train at grade crossing.

(e) Additional time required (which may not be necessary) to lubricate engine and pump up air line.

(f) In addition to the direct increase in costs incident to stops for water and fuel, the slower speeds may be reflected in less attractive service to shippers with a resulting loss in gross receipts.

On the oeher hand, the following losses result from the use of heavier tenders:

(1) Additional weight in the tender diminishes by so much the pay freight that the locomotive will haul. This loss, however, may be fanciful rather than actual, as the elimination of a water stop at the foot of a limiting grade may permit an increase in train load that will more than offset the increased weight of tender and its lading.

(2) Greater wheel concentrations cause greater damage to track and track structures.

(3) Fixed, as well as operating, expenses for tenders are increased.

These items of delay, of course, will vary according to the local conditions. Where water and fuel is taken in connection with regular station stops the time lost in deceleration and acceleration will not usually be affected, but other delays will often be affected.

In order to utilize an available source of supply, the water station is often located at the foot of a grade. That location amplifies the delay further because of the difficulty of accelerating the train to its original speed. This also results in greater wear on train equipment in stopping and greater loads on drawbars in starting, which often results in break-in-two's, in addition to increased fuel and water consumption.

The committee found that there is very little authentic information to be had on this subject, and therefore, in order to have the advantage of the latest data concerning the most recent development in the use of large engine tanks, including the corresponding respacing or elimination of water and fuel stations, a questionnaire was sent to the chief operating officers of a number of important railways which have obtained operating economies from such changes in equipment and railway facilities.

The detail of information furnished by the various railroads that replied to the questionnaire showed:

(1) Railroads have been changing from small to large engine tenders since 1918. The greater number of changes were in 1926 and 1927. Engine tenders having capacity of from 7,000 gal. to 12,000 gal. were replaced with larger tenders. The largest tender in service has a capacity of 21,700 gal. of water and 26 tons of coal. Other sizes range from 10,000 gal. water capacity and from 18 to 24 tons of coal.

2. Larger engine tenders effected an increase in the average maximum distance between water stops of from 37 miles to 61 miles, or 73 per cent. The average minimum distance between water stops increased from 16 miles to 35 miles or 119 per cent. The average maximum distance between fuel stops increased from 69 miles to 102 miles, or 48 per cent. The average minimum distance increased from 53 miles to 58 miles, or 10 per cent.

(3) The average number of water and fuel stops eliminated by the use of large tenders was 2.7 and 1.4, respectively, for each engine run.

(4) The average length of engine district in the study is 150 miles.

(5) Average freight train load—4,550 tons.

(6) Average tractive power of locomotive—85,500 lb.

(7) Average time saved per water stop—26 minutes.

(8) Average time saved per fuel stop—19 minutes.

(9) Average pounds of fuel saved per water stop—910.

(10) Average gallons of water saved per water stop—770.

Appendix C—The Most Economical Makeup of Track to Carry Various Traffic Densities

No work was done by the committee on this subject during the year, on account of waiting until the Committee on Rail reports upon the economies of the different sizes of rails.

Appendix D—Units for Operating and Equipment Statistics Required by the I. C. C. in Cost Comparisons of Transportation, Equipment and Roadway Maintenance

The committee reported progress and requested that the subject be reassigned for a final report next year.

Appendix E—What Justifies a Change from Flat Switching to the Hump Method in Any Given Yard

Last year the committee submitted as information a summary of answers received to a questionnaire on hump yard operation. This year detailed information as to the operation of a number of hump yards with both car riders and car retarders was obtained and the following summary of this information was included in the report:

From a study of this and other information, the committee is of the opinion that conditions as to number of classifications, ratio of cuts to total cars handled, time element and physical conditions are so varied that a definite answer in terms of volume and conditions is not possible, but that limits within which detailed study of the advantages of changing from flat

to hump switching would be justified, can be indicated, and methods to be followed in making such a study can be outlined.

A change from flat to hump switching is rendered desirable by:

(1) Increase of volume beyond the ability of a flat yard to handle; (2) Necessity of increased speed; (3) Economy of operation.

The volume of business as measured in cars handled in and out of a yard in itself is not the determining factor unless accompanied by a definite number of classifications and a certain ratio of cuts per 100 cars handled and will also depend upon whether or not continuous operation is necessary.

The possibilities of improved service and economy in operation by a change from flat to hump switching should be studied when any or all of the following conditions are present:

(1) The number of cars received and classified continuously over the 24-hour period exceeds 800.
(2) The number of classifications regularly made exceeds 10.
(3) The ratio of classifications exceeds 1:5, i.e., over 20 cuts per 100 cars.
(4) Necessity for increased speed of operations.
(5) Over 20 per cent cars handled to be weighed.

The cost of hump yard operation is divided into five elements:

(1) Supervisory and clerical.
(2) Engine service.
(3) Car riders or retarder operators.
(4) Maintenance of increased facilities.
(5) Interest on increased facilities.

Supervisory and Clerical.—This feature of cost would be the same under either flat or hump switching except that there is a possibility of reduced cost in hump switching if the operation is not continuous, but for purposes of comparison may be considered the same.

Engine Service.—The number of cars which can be brought from a receiving yard and classified over a hump depends upon:

(a) The number of riders assigned and the facilities provided for return to the hump.
(b) Number of cars per train and number of cars per cut.
(c) Design of yard with special reference to speed with which cars will clear the lead. The range is from 50 to 100 cars per hour and for purposes of study may be taken as 75.

The number of switch engines depends upon the number of cars and with over 600 cars per 8-hour shift, an engine will be required for hump service and a second for trimming and making up trains. Where the volume is light the work may be divided, the same engine doing both the humping and trimming.

The number of eight-hour shifts required depends upon the number of cars to be humped and the necessity for continuous operation. If continuous operation is necessary, the minimum number of shifts required is three and will vary depending upon the number of cars to be humped.

Crew and Wage Costs.—The number of men in the crew in practice varies from two, engineer and fireman, to six, engineer, fireman, foreman and three helpers, but the usual crew is five, engineer, fireman, foreman and two helpers, and wage cost is approximately $34 per shift. The fuel and other cost may be taken from available records for flat switching.

Car Riders.—The number of cars handled per car rider per shift varies with the length of the classification yard, etc., ranging from 30 to 60 with an average of 45. Car riders are generally paid current wages for switchmen.

The number of retarder operators depends upon the design of the yard but for estimating purposes may be assumed at four per shift and wage cost $31.20 per shift.

Maintenance.—There is very little if any difference per mile of track for track maintenance as between flat and hump yards, but when retarders are used there is an increase in the cost of maintenance.

Interest.—Interest on the total outlay should be allowed for at the current rate.

Appendix F—Problems of Railway Operation as Affected by the Introduction of Motor Trucks and Bus Lines

In its report, the committee presented a thorough statement of the present status of bus competition with the railways. This was arranged under four general headings: General; Opposition before public utilities commissions to the granting of permits to independent operators; Regulations as to rates, schedules, taxes, safety appliances, financial responsibility, etc.; Attempts to incorporate in rail service those features found attractive in highway motor service, or to offset them with other compensating attractions; and adoption of the motor vehicle by the railways as a part of their own service.

As a result of its investigations the committee expressed the following opinions for consideration by the executives of the railways with respect to automotive highway competition:

(1) The automotive highway vehicle has a real place in the transportation field.

(2) Continued efforts should be made to bring about equality in taxation and regulation, both with respect to intrastate and interstate operations.

(3) The public desires good service whether given by bus, truck, rail motor car or steam train. By good service is meant giving the character of service desired by patrons in any of the above manners, and with due regard to the economies of the situation. Whether the service be great or small, it should be as nearly as possible what patrons desire, and of such nature as to meet the commendation and not the criticism of patrons.

(4) The rail motor car should be adopted on all runs where economic justification can be found for its use. That is, where it is necessary to furnish a rail service and that service can be performed by the rail motor car.

(5) The automotive highway vehicle should be used by the railroads for the transportation of passengers and freight wherever economic justification is found.

(6) No mathematical formula can be worked out to fit all cases. Each situation should be studied and conclusions arrived at, based on the individual study.

(7) Generally speaking, if the study indicates doubt as to the possibility of securing a revenue of at least 25 cents per mile along any route, whether the vehicle be one to move on the rail or on the highway, the service should be abandoned if possible.

If the possible indicated revenues are over 25 cents per mile, then if highway conditions are right serious consideration should be given the possibility of using highway motor service and eliminating rail trains.

If the revenues show indications of running above 45 cents per mile and it is not possible to use highway vehicles, rail motor cars should be substituted for steam train service up to the ability of the rail car to meet the demands properly. The field of the rail car is widening with the construction of heavier cars, some of 800 hp. being already in service, although the costs of operating such heavier cars exceed the figures quoted above.

(8) Motor trucks should be used in terminal transfer work, replacement of local freight trains and in all services where economic or traffic considerations make it desirable.

L. C. L. Containers

The committee also made a brief report covering the use of L. C. L. containers by the railways, beginning with a history of the container idea and continuing with a brief statement concerning each of the following schemes which have been devised during the last ten years to permit the flexible handling of freight:

(1) The Bonner plan; (2) The Kellett plan; (3) The tractor-trailer plan used by the Chicago, North Shore & Milwaukee Electric Railway; (4) The Perin-Walsh roll-off plan; (5) The L. C. L. Corporation plan in use on the New York Central and Lehigh Valley; (6) The Church freight service plan; (7) The American Freight Service Incorporated plan.

The committee stated that it had not, as a whole, studied these items in detail and presented them only for the guidance of members.

Appendix G—Economies Resulting from Radio for Long Freight Trains

No written report on this subject was presented by the committee, however, progress was reported in the investigations being made.

Discussion

[The report was presented by Chairman J. M. Farrin (I. C.), who stated that while the committee originally had no revisions of the Manual to recom-

mend, it had received the following suggested revision from the Committee on Signaling with the request that it be approved for inclusion in the Manual. The revision read as follows:

"Where the volume and distribution of traffic on single or multiple track are such as to cause congestion, overtime, or delay to trains, directing a movement of such trains by signal indications in lieu of train orders and timetable superiority is recommended as safe and as affording a means of increasing the capacity or facilitating the movement of traffic."

The report on the methods of obtaining a more intensive use of existing railway facilities was presented as information by Subcommittee Chairman M. F. Mannion (B. & L. E.). Following this, the report on methods or formulas for the solution of special problems was presented by J. E. Teal (C. & O.). The report treated of the effect of increasing the capacity of engine tenders on the economical spacing of water stations and was presented as information.]

C. R. Knowles (I. C.): I want to call attention, however, to the report of the Water Service committee of last year on the economical spacing of water stations. At that time exceptions were taken to the report of our committee giving the approximate waste of coal at ½ ton per train stop. The statement was made on the floor at that time that 400 lb. would more nearly represent the average. The committee report this year shows an average of 910 lb. of fuel saved per water stop.

Chairman Farrin: With reference to that 910 tons, I should like to call attention to the fact that the average tractive effort of the engine consuming 910 lb. was 85,500. We were speaking of the average for the railroads of the United States, not for an average of a railroad that is using engines having tractive effort over 80,000 lb.

Mr. Knowles: Our committee did not consider the average tonnage of all trains throughout the country. I believe the average tonnage is about 7,500 tons in this report.

We should consider the spacing of water stations and large engine tenders from the standpoint of eliminating the unnecessary stops. The important factor is to provide sufficient water-carrying capacity to avoid unnecessary stops, because the cost of operation and maintenance of water stations is a mere bagetelle compared to the cost of stopping trains.

[Subcommittee Chairman J. F. Pringle (C. N. R.) then presented the report on conditions justifying a change from flat switching to the hump method, which was submitted as information. The report on the influence of motor trucks and motor coaches on railway operation was presented as information by Miss Olive W. Dennis (B. & O.), a member of the committee, in the absence of Subcommittee Chairman M. F. Steinberger (B. & O.).]

President Faucette: This report is received as information from Miss Dennis and I wish to say in behalf of the association that it was presented ably, clearly and concisely, indicating a thorough knowledge of the subject. May I further take the opportunity to state that in 30 years of our existence, this instance marks something new in the annals of this engineering association. Miss Dennis is the first lady to have presented to this association an engineering report, and in recognition of that will you please stand a moment?

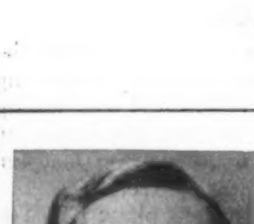
[The audience rose and applauded.]

Chairman Farrin: Mr. President, I also want to add that our committee has had a great deal of valuable help and advice from Miss Dennis.

[The committee was then excused with the thanks of the association.]

Report of Committee on Rail

Committee devoted much attention to transverse fissures and results obtained by detector car



Earl Stimson
Chairman

THE committee presented reports covering the following subjects:

(1) Revison of Manual.

(2) Details of mill practice and manufacture as they affect rail quality and rail failures, giving especial attention to transverse-fissure failures, collaborating with the Rail Manufacturer's Technical Committee (Appendix A).

(3) Compilation of statistics of all rail failures, making special study of transverse-fissure failures (Appendices B and C).

(4) The cause and prevention of rail battering, collaborating with the Committee on Track (Appendix D).

(5) The economic value of different sizes of rail (Appendix E).

(6) The reconditioning of battered or worn rail ends by the electric welding process, with special reference to the effect upon rail (Appendix F).

(7) Study the drilling and spacing of holes in rails of all weights, and sizes of bolts for use with each weight.

(8) Consider the revision or elimination of the specifications for spring washers, collaborating with the Committee on Track.

(9) Compile information of tests of alloy steel rails, addresssing the various railroads for records of such tests as they may have made (Appendix G).

The committee recommended that a revision be made in paragraph 401 (b-4) of the Standard Specifications for the Manufacture of Open-Hearth Steel Girder Rails of Plain, Grooved and Guard Types to replace the present paragraph in the Manual. It also recommended that the revision of the definition of batter; the rail-batter gage and the 24-in. straight edge; the forms for the recording of track data and the form entitled "Rail Batter Notes" as contained in Appendix D, together with the conclusion as to reconditioning rails by welding in Appendix F be approved for inclusion in the Manual. The reports

in the other appendices were presented as information.

Revision of the Manual

At the request of the American Electric Railway Engineering Association, the committee recommended for adoption the following revision of paragraph 401 (b-4) of the "Standard Specification for the Manufacture of Open-Hearth Steel Girder Rails, of Plain Grooved and Guard Types." This revision is intended to harmonize the standard specification with similar specifications of the American Electric Railway Association, Engineering Section, which association represents the largest users of this type of rail.

It is recommended that paragraph 401 (b-4) reading:

"Any variation which would affect the fit of the splice bars will not be allowed"

be changed to read:

"No change will be allowed in dimension affecting the fit of splice bars, except that the fishing template approved by the purchaser may stand out not to exceed 3/32 in. laterally."

Other material for Manual revision proposed by the committee appears in connection with subject (4) Rail Batter, and subject (6) Reconditioning of Battered or Worn Rail Ends.

Appendix A—Mill Practice

In collaboration with the Rail Manufacturer's Technical Committee, an investigation was made of the cause of shattering cracks in rail steel. Special rails were made which, during their manufacture, were subjected to different cooling conditions, heat treatments, etc., and these rails are now undergoing service tests in track. Sufficient time has not elapsed to enable any but a progress report to be made at this time. This work will be continued.

The completion of the transverse fissure detector car, which was thought to be imminent at the date of the A. R. E. A. convention in 1928 was delayed considerably due to pick-up electrical contact difficulties occasioned by the high-resistance skin which was found to exist on the running surface of rail heads. An entirely new method of pick-up has since been devised which has overcome this difficulty. The completed detector car successfully passed its acceptance tests on September 13 and 14, 1928, and was subsequently accepted by the committee.

On October 14, after testing 166 track miles of rail on the New York Central, between Beacon and Rensselaer, N. Y., the detector car started on its tour of the country under leases to various railroads for maximum periods of six working days each, to enable the engineers of as many roads as possible to familiarize themselves with the usefulness of this device.

The committee believes that the detector car will not only be a practical device enabling the removal of defective rail from track before failure, but will also afford means of investigation which will add greatly to our knowledge of this type of failure. The history of this development was summarized to date by W. C. Barnes, engineer of tests of the committee, and included in Appendix A.

Appendices B and C—Rail Failures, with Special Reference to Transverse Fissures

Rail failure statistics were presented for the year ending October 31, 1927, compiled in accordance with the standard method of basing the failure rate on mile years of service in track.

The rollings for 1922 and succeeding years were embodied in these statistics, the tonnages and track miles reported being as follows:

Year Rolled	Tons	Track Miles
1922	1,103,583	6,997
1923	1,520,046	9,657
1924	1,434,165	9,036
1925	1,673,656	10,345
1926	1 720,748	10,380
Totals	7,452,198	46,415

Table 1 shows the average failures per 100 track miles which occurred in one to five years' service of all of the rail reported on, together with the results taken from previous reports, including both Bessemer and open-hearth rails. The 1922 rollings, whose period of observation is now concluded, show a slightly higher failure rate than the rollings of 1921, as was forecast in last year's report. The four-year record of the 1923 rollings indicates that no improvement in their failure rate can be expected in next year's report. The appended chart shows diagrammatically the five-year averages from Table 1.

Table 1—Average Failures Per 100 Track Miles

Year Rolled	Years Service 1	2	3	4	5
1908	......	......	......	......	398.1
1909	......	......	......	224.1	277.8
1910	......	......	124.0	152.7	198.5
1911	......	77.0	104.4	133.3	176.3
1912	28.9	32.1	49.3	78.9	107.1
1913	12.5	25.8	44.8	69.5	91.9
1914	8.2	19.8	32.9	50.9	74.0
1915	8.9	19.0	34.2	53.0	82.4
1916	11.8	29.2	47.7	70.6	105.4
1917	21.6	38.9	66.0	110.5	137.0
1918	8.9	27.6	54.0	92.8	125.4
1919	14.8	39.4	73.7	104.8	115.7
1920	14.2	32.4	63.1	84.5	119.6
1921	10.9	34.9	56.9	70.9	98.9
1922	15.9	34.8	55.2	80.4	110.0
1923	14.3	33.2	57.6	86.0	......
1924	14.0	33.4	58.3	......	......
1925	15.5	36.6	......	......	......
1926	17.1	......	......	......	......

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W. P. Wiltsee, ch. engr., N. & W., Roanoke, Va.
L. Yager, asst. ch. engr., N. P., St. Paul, Minn.
J. B. Young, engr. tests, Reading, Reading, Pa.

The report also contained a table to give a summary from 15 years' reports, showing track miles of rail laid originally and the total failures in addition to the failures per average 100 track mile in service, for periods of one to five years, from Table 1. The average results of the rails from each of the mills were shown in another table, from which a diagrammatic chart was made.

Other tables and charts were presented to show the performances of rails rolled at each of the mills shown during the five-year period covered.

Transverse-Fissure Failures

The transverse-fissure statistics constitute a cumulative record of 32,088 simple transverse-fissure failures that have been reported up to and including January 31, 1928, and were presented in the form of tables showing failures by roads and years, beginning with 1911, the report for each year ending with January 1 of the following calendar year.

Table 1 corresponded with Table 1 of the report of 1928, and showed the number of simple transverse-fissure failures reported by each of 53 reporting roads and the years in which such failures occured. The Pennsylvania fissure failures which occurred in the last quarter ending January 31, 1928, and which totalled 251, were reported too late for inclusion in these statistics.

The accumulated total reported to January 31, 1927, from all rollings was 27,346 and that to January 31, 1928 was 32,088, or an addition during the fiscal year 1927 of 4,742 fissure failures. Adding the 251 Pennsylvania failures above mentioned, the total addition for the year was 4,993, an average of approximately 14 per day, and the accumulated grand total was 32,339.

The total of 4,993 for the year 1927 exceeded the total of 4,596 for the year 1926 by 397, of which 151 were from the four roads not previously reporting, leaving a net increase over the year 1926 of 246 fissure failures reported from previously reporting roads.

Table 2 likewise corresponded with Table 2 of last year's report and segregated all fissure failures accumulated from the year rolled to January 31, 1928, for each year's rollings from each mill, not weighted by the tonnage output of the mills and by the amounts of traffic carried. This table is most useful in comparing the failures in the various rollings from any one mill.

The rollings of 1910 from all mills continued to show the maximum number of accumulated fissure failures, 3,166, of which total 254 were reported during the year 1927. This is mostly due to the poor record of the 1910 rolling from Illinois. The 1913 rollings from all mills continued to be a close second with an accumulated total of 3,129 failures.

The greatest number, 440, of failures for all mills reported in 1927 occurred in the 1917 rollings, which are again attributed to the Illinois 1917 rail. Comparison with last year's report showed that the greatest number, 502, of failures reported for all mills in 1926 also occurred in 1917 rollings.

Attention was called to the marked increase in fissure failures reported during the last few years as occurring in the first year of service, as follows:

1925 rollings, all mills, 29 failures in 1925
1926 rollings, all mills, 50 failures in 1926
1927 rollings, all mills, 114 failures in 1927

Appendix D—Cause and Prevention of Rail Batter

The report on this subject was presented to stimulate interest on the part of the various railroads so that sufficient data may be obtained to make the final results of value to all. The cause and prevention of rail batter require extensive investigation for a complete answer and, though individual cases may show the opposite, if the same general trend is found in the batter of rail of three years' service and thirteen years' service; of low tonnage and high tonnage; of good maintenance and under maintenance; or of one railroad or another, it is a fair assumption that this trend is real.

Among the causes of rail batter, aside from traffic without which there would be no batter, is a difference in the elevation of the top surfaces of the rail. From investigations of the committee, it was found that the minimum batter results when the leaving rail is .005 in. higher than the receiving rail. Other causes are differences in contour of the fishing surfaces of the rail and joint bar; excessive joint gaps, and under-maintenance of the track in various forms. To determine the influence of track maintenance on batter, the Boston & Maine took a series of readings on 50 and 30 consecutive joints at two locations, respectively, where ordinary maintenance obtained, and on 50 consecutive joints at one location where a special effort was made to insure as nearly perfect maintenance as could reasonably be expected. The rail and track structure in each location was uniform. Readings were taken at each location every day for the first few days after the rail was laid, then once or twice a week for seven weeks, and indicated that batter can be reduced by improving the maintenance condition.

The Boston & Maine has tested a process, called "Metalayer," which has been applied on rails, joints, tie plants, abrasion plates, bolts and nuts. It consists of sand-blasting, to clean and roughen the steel, and then spraying with molten zinc, aluminum, lead, tin, copper or monel, as the case may be. The bond between the sprayed metal and the steel is purely mechanical and if the sand-blasting is done properly, the coating is attached firmly enough to allow of machining if necessary.

After three months, tests indicated a perfect bond through the joint for propulsion of current. Four joints in automatic signal territory have been unbounded for more than a month. The cost of this treatment is high and considerable improvement in joint and bond conditions will have to obtain to justify the added cost.

This road has also taken comparative readings, converted to hundred thousandths of an inch per month, on the German rail made by Krupp, which indicate that, as far as batter is concerned, they are giving very good service. This may be due to the one point average higher carbon content. These rails showed a minimum of segregation between the "O" and "M" points, but are showing a tendency to split which is as yet unexplained.

The committee also presented further information on the extensive tests conducted by Hunter McDonald, chief engineer of the Nashville, Chattanooga & St. Louis, which have been referred to in previous reports.

The committee recommended that the following definition of batter be adopted for inclusion in the Manual to replace the present definition:

Half-Inch-Point Batter.—The distance in thousands of an inch between the bottom of a straight edge 12 in. to 24 in. long, applied along the center line of the worn surface on the top of the rail (with one end coinciding with the end of the

rail) and the top of the rail measured at a point ½ in. from the end of the rail.

End Batter.—The distance at the end of the rail measured as for half-inch-point batter.

Total Batter.—The sum of the half-inch-point batter and the end batter.

(A) For welding, resawing and renewal purposes, the half-inch point-batter taken with a taper gage in 64ths of an inch will be sufficient.

(B) For statistical purposes the batter should be measured with a dial micrometer in thousandths of an inch. For uniformity the use of a standard batter gage is recommended.

It also recommended that a 24-in. straight edge with a dial micrometer be used for taking batter measurements for two reasons: to obtain sufficient bearing on the unbattered surface of badly battered rail and to obtain greater uniformity of results when comparing readings taken on various railroads; and the adoption of two forms which it prepared for recording batter data.

Appendix E—Economic Value of Different Sizes of Rail

The treatment of this subject was divided into two parts: one, a theoretical study showing stresses in the various sizes of rails caused by the same loading and also how a change in the size of the rail affects the pressure on the subgrade, and the stiffness of track, while the other was a practical study, which is incomplete, showing the costs of installing and maintaining 85-lb. and 90-lb. rail for various traffic densities. An abstract of the report folows:

The theoretical study is based on tests made and formulas developed by the Special Committee on Stresses in Railroad Track as reported in Volume 19, p. 875, of the Proceedings.

The function of a rail is to transmit the wheel loads to the ties and in order to do this it must possess a head of such shape and hardness as to withstand the wear of the wheels and also sufficient girder strength to distribute the loads to the ties without undue stress. From this it is seen that the economy of a rail is dependent upon its head to resist wear and its general cross section to resist stress, the former being determined from experience, while the latter is more subject to theoretical computations. In the theoretical study only stress in the base was considered.

From the above it is apparent that the first thing to do in studying the economic value of the different weights of rail is to compute their stresses for varying conditions of roadbed and in order that results throughout the discussion might be directly comparable all stresses were computed for Illinois Central 2-10-2 type of engine running 50 miles per hour and having wheel loads and spacing as shown on Chart "A". The results were plotted on Chart "A", which shows plainly how the different rails compare with each other under the same load and track conditions. Attention is called to the fact that the curves representing the different rails are practically parallel to each other and that stress in rail becomes less as U, the roadbed factor of stiffness, increases. However, from the formula given above it is to be noted that the bending moment and consequently the stress varies as the fourth root of U, so that its effect is not very great.

By referring to page 184, Bulletin 291, Vol. 28, A. R. E. A., for November, 1926, a chart will be seen showing variation of values of U for different track makeups, from which it is to be noted that a fairly average track has a value of U equal to 1,400. Now, if we take this value of U and by means of Chart "A" determine the stress in each of the different rails, the results can be plotted which indicates how stress varies with the weight of rail. It is interesting to note on such a chart that the slope of the line from 70 lb. to 85 lb. rails (which were old A. S. C. E. sections), is greater than for those from 90 lb. to 136 lb., which represent the later sections, showing that in the early days the principal idea in increasing weight of rail was to lessen stress, while the later sections evidentally distributed the metal for wear and lateral stiffness as well as stress. Above 90 lb. the line is practically straight, indicating that for all practical purposes, the distribution of metal is constant. A chart was plotted to show the moments of inertia of the same rails plotted against their stress, which indicated that as heavier rails are designed their moments of inertia increase in about the same ratio as their weight.

Changing weight of rail affects the stiffness of the entire track structure and by referring to Charts 7 and 8, pages 184 and 195, Bulletin 291, Vol. 29, A. R. E. A., for November, 1926, we can tabulate the stiffness of track factor U and the pressure in tons per square foot on subgrade for each weight of rail using 7 in. by 9 in. by 8 ft. 6 in. tie as follows:

Wt. of Rail	6 In. U	6 In. Pressure	9 In. U	9 In. Pressure	12 In. U	12 In. Pressure	15 In. U	15 In. Pressure	18 In. U	18 In. Pressure	21 In. U	21 In. Pressure	24 In. U	24 In. Pressure
85 lb.	1,125	4.35	1,170	2.50	1,230	1.68	1,280	1.30	1,320	0.90	1,390	0.71	1,440	0.58
90 lb.	1,180	3.90	1,225	2.25	1,290	1.50	1,350	1.25	1,400	0.84	1,450	0.66	1,510	0.52
100 lb.	1,230	3.80	1,290	2.15	1,340	1.43	1,410	1.21	1,460	0.76	1,525	0.61	1,580	0.49
110 lb.	1,300	3.35	1,375	1.92	1,430	1.30	1,500	1.00	1,550	0.68	1,600	0.55	1,650	0.45
127 lb.	1,440	2.95	1,500	1.68	1,550	1.13	1,600	0.79	1,650	0.60	1,700	0.48	1,750	0.39
136 lb.	1,550	2.70	1,600	1.48	1,640	0.98	1,700	0.71	1,740	0.55	1,800	0.45	1,850	0.36

The effect of the weight of rail on U can be shown graphically by plotting the values from Table I, shows that U increases uniformly on a straight line as weight of rail increases and that this rate of increase is the same for all depth of ballast, being 8 for each pound increase in weight of rail.

Another chart was constructed from the values of the pressure on subgrade given in Table I and it is interesting to note that as ballast is increased in depth the size of rail has a lessening effect on the pressure.

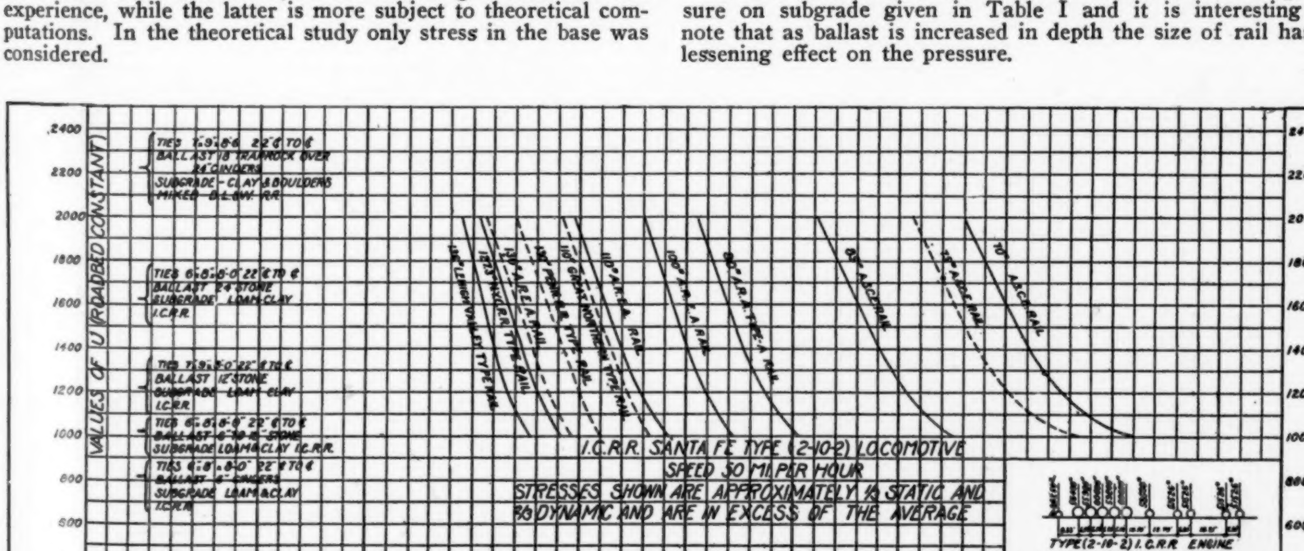

Chart A—Showing Stress in Rails for Various Values of "U"

Also, by means of Table I, still another chart was constructed, showing how value of U varies with different pressure values and different depths of ballast for the various sizes of rails, this chart being useful in arriving at the approximate relation between U and the pressure on the subgrade.

In the above discussion we have seen how the different sizes of rail affect the stiffness of track U, pressure on subgrade and stress in rail under same conditions of loading, but what is wanted is information on how much better a track is with a certain size rail than one of some other size. A very good idea of this can be obtained by assuming a track with 7 in. by 9 in. by 8 ft. 6 in. ties on 15 in. of ballast and tabulating values from Table I as follows:

Weight of Rail	U	Pressure Tons per Sq. Ft. on Subgrade	Stress in Bottom Flange from Chart A lb.
70-lb. A. S. C. E.	1,145	1.85	48,200
75-lb. A. S. C. E.	1,190	1.60	45,200
85-lb. A. S. C. E.	1,270	1.30	39,800
90-lb. A. R. A.-A.	1,310	1.15	33,000
100-lb.	1,395	1.05	30,200
110-lb. A. R. E. A.	1,480	0.90	26,600
127-lb. N. Y. C.	1,620	0.80	21,500
136-lb. Lehigh	1,690	0.70	20,300

If we take the values of 70-lb. rail as unity and figure the per cent of increase for each of the other size rails, a chart

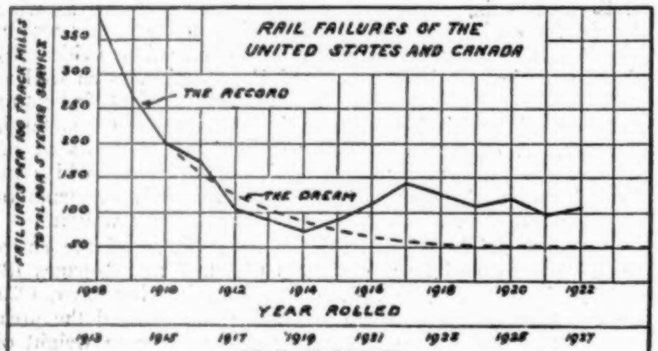

Chart of Rail Failures in United States and Canada, 1913 to 1927, Inclusive

can be constructed showing the per cent increase in values of U, stress in rail and pressure on subgrade as the rail is increased in weight. An inspection of these curves shows that U can be increased 47½ per cent, stress in rail decreased 58 per cent and pressure on subgrade decreased 62 per cent. Just how these three component qualities affect the entire track structure from a practical standpoint is not known, but the probability is that it is in the neighborhood of 50 per cent, that is, that the track as a whole can be bettered 50 per cent by changing from 70-lb. to 136-lb. rail, everything else remaining the same.

Practical Study

An investigatilon made over a 100-mile stretch of double track railway through Illinois on the Illinois Central was made for a 26-year period from 1901 to 1926, inclusive, and amount of section labor per year for each track was determined together with rail renewals and traffic carried. This track, in 1901, was laid with 85-lb. rail, being gradually replaced with 90-lb. rail in the later years. The information obtained was plotted on chart H, showing costs in cents per million gross ton miles for varying traffic densities. On this same chart, the results obtained by J. B. Baker, engineer of maintenance of the Pennsylvania and presented by him in a paper read before the Roadmasters' and Maintenance of Way Association at their 1920 convention, were also plotted by converting cars per day into gross ton miles per year by multiplying the number of cars by 48.4, which was average loading per car on Pennsylvania for 1921. It is to be noted that a discrepancy exists between the Illinois Central results and the Pennsylvania results, the Illinois Central costs being somewhat higher. Sufficient data is not at hand at the present time to determine the correctness of any of these curves, but they are given to show progress and how the problem is being attacked. It is hoped that with additional data for all weights of rail sufficient information can be obtained to enable curves for each weight of rail to be plotted so that their intersections will give the economical traffic density for various weights of rail.

Appendix F—Reconditioning Worn Rail by Welding Processes

After an investigation of welding processes for reconditioning rail, with special reference to the effect on the quality of the rail, the committee recommended that the following conclusion be printed in the Manual:

"The reconditioning of rail ends by either electric or oxy-acetylene welding has not been found detrimental to the rail. Either method gives an adequate wearing surface to the rail ends when the metal is properly applied. It provides an economical means for restoring battered rail ends to their true surface, and is recommended as good practice."

Appendix G—Tests of Alloy Steel Rails

Owing to the widespread interest in intermediate manganese rail, the committee confined its efforts to securing as complete data as possible with respect to this class of rail. With this end in view, a questionnaire was addressed to railroads that have purchased intermediate manganese rail and the replies were shown in the report.

Returns to the questionnaire indicated that from 1924 to 1928, inclusive, somewhat over 225,000 gross

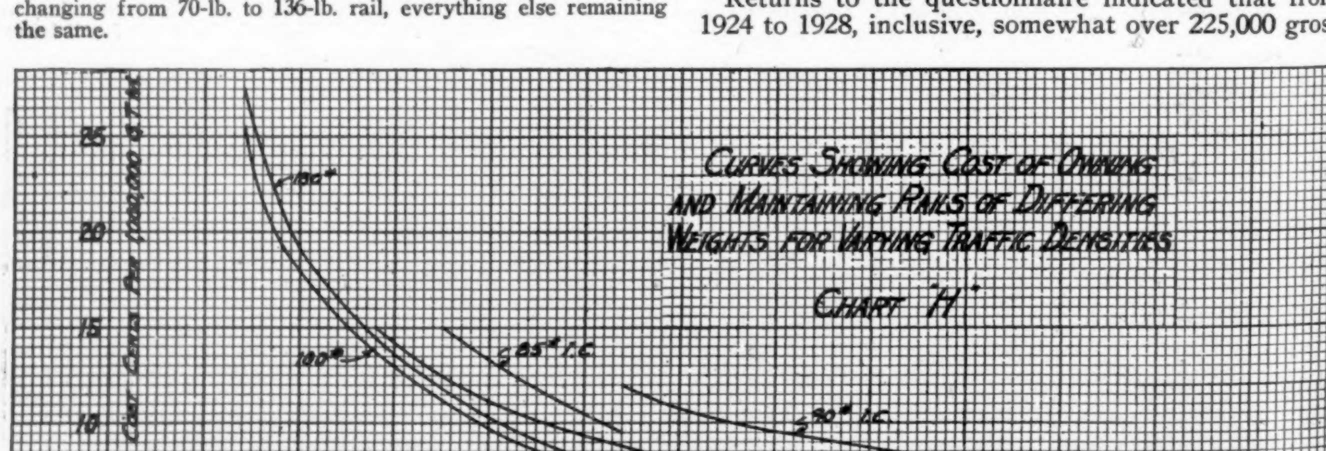

Chart H—Showing Cost of Maintaining Track With Differing Weights of Rail and Varying Traffic Densities

tons of intermediate manganese rail have been rolled and placed in service in the United States. The returns also indicated that the tonnage purchased is rapidly increasing.

The committee pointed out that on the whole the replies were favorable to intermediate manganese steel, particularly from the Chicago, Burlington & Quincy, the Delaware, Lackawanna & Western and the New York Central Lines, who purchased 213,112 tons out of the 229,059 tons of intermediate manganese rails reported. The Atchison, Topeka & Santa Fe report on 13,000 tons was favorable except as to the percentage of X-Rayls which was excessive, due in a large measure to the special treatment given the ingots.

The Pennsylvania and the Reading, with tonnages of 942 and 30 tons, respectively, reported unfavorable results, but it was pointed out that these small tonnages were of an experimental nature with excessive variations in the percentages of carbon and manganese. The Pennsylvania rejected two heats due to drop-test failures out of the 16 heats reported. Both heats were high in manganese and carbon. Five other heats were over the specified limits in chemistry, but were accepted for experimental purposes and study. Their unsatisfactory results were apparently due to these unusual variations. The Reading, in its 300 tons, had four heats shipped, three of the heats being 0.45 carbon or less, which, together with the comparatively low manganese content, made them quite soft, and produced unsatisfactory service results. The fourth heat with 0.72 carbons and 1.30 manganese is still in track and giving satisfactory service.

The report also contained the following tabulated information:

1. Tonnage purchased by mills, years, sections and weight per yard.
2. Carbon limits specified.
3. Manganese limits specified.
4. Other special requirements.

Monograph—Rail and Wheel, by W. C. Cushing

In addition to the reports on the various subjects assigned, a monograph was included by W. C. Cushing, engineer of standards of the Pennsylvania, entitled "Rail and Wheel." The monograph is divided into three parts, the first comprising a review of mathematical and technical analysis applied to rail design, which was presented by Mr. Cushing at the International Railway Congress Association in London in 1925. The second part is a critical survey of the physical requirements for steel rails, while the third part treats of the genesis of the transverse fissure.

Discussion

[The report was presented by Chairman Earl Stimson (B. & O.), with President Faucette in the chair, and the matter relating to the revision of the Manual was submitted by A. F. Blaess, (I. C.) *who moved that the revisions suggested be adopted. The motion was put to a vote without discussion and carried.*]

Chairman Stimson: The causes of rail failures of fissure and other type, and their relation to mill practice has for years been the subject of much discussion and investigation. The two most interested parties to the rail question, namely, the makers and the users, have gotten together for joint action on this subject. As media of contact, the rail manufacturers have named their Technical committee, and the American Railway Association has officially named the Rail committee.

These two committees have organized as a joint committee to study the details of mill practice and manufacture as they affect rail quality and rail failures, giving special attention to transverse-fissure failures. Special rails have been made which, during their manufacture, were subjected to different cooling temperatures, heat treatments, etc., and these rails are now undergoing service tests in tracks.

Several other agencies are conducting investigations of rails and rail steel, and the committee is keeping in touch with such investigations. Every railroad investigates its own failures to some extent, and it is desired that the committee be kept advised of what investigations are being made by the railroads, what data they have developed and what conclusions they have reached.

Aside from service tests that are now going on, the outstanding feature of the Rail committee's work this year has been the completion and the actual putting into service of the long-heralded Sperry transverse fissure detector car. W. C. Barnes (engineer of tests, Rail committee) who has followed its development in service very closely, will tell you about it.

Mr. Barnes: The paper in Bulletin No. 315 sketches the high lights and development of detection of transverse fissures in track up until the car was put in operation. The A. R. A. detector car was accepted by the committee on October 2, 1928, and shortly thereafter started on a tour of the country to demonstrate its value. To date, this car has tested approximately 1,000 miles of track, for the first 900 miles of which the records have come in and the car has detected more than 121 badly defective rails.

Those are divided somewhat as follows: There were 50 transverse fissures, 29 horizontal fissures, (I might say there are more than 29 because we stopped counting the horizontal fissures), 15 piped rails, 3 broken rails, 2 cracked webs, 1 broken base, 5 split heads, 1 crushed head, and 15 miscellaneous defects. On the average, there is one fissure rail for each eight miles. The maximum with the car was one every three miles, the minimum about one every 100 miles. The other car that has been operating has obtained a maximum record of something like two to a mile. The great majority of these failures have been verified by breaking the rail.

The efficiency of detection is something which possibly needs a little discussion, since it is a matter very difficult to prove. When a transverse fissure develops in the track, which had not been recorded by a previous test, the question arises as to whether it was a failure of the car to detect that fissure or whether that fissure has developed since that test was made. The old idea, concerning rails found to fail after 20 years' service, for instance, was that it took possibly 20 years to develop the fissure, but the experience that we are getting of late indicates clearly that that idea is all wrong.

The transverse fissure statistics for this year show a record of 114 fissures having developed within the first year of service of rails in 1927. Furthermore, I have records which give proof of the rapid growth of a transverse fissure in main line track.

In one rail which was examined, there was an indication of a fissure whose area was less than 0.03 sq. in. Five days less than two months thereafter, when another test was made of the same rail, two transverse fissures were present, and their areas were foretold correctly by the test.

In one case, the one that had measured about 0.03 sq. in. previously had increased to practically 40 per cent of the area of the rail head, and in the other case the newly found fissure was about 30 per cent. This proves that these things grow very fast at times.

The car is being improved from week to week, additional apparatus and equipment is being put on which is improving the speed of detection and the accuracy of detection and the records now made are not at all comparable with those made in the beginning.

With regard to accuracy, I should mention that in a retest made on a certain road for 85 miles every flaw appeared on the original record with the exception of one, which I think is an extremely good record.

President Faucette: Would Mr. Sperry care to make a few remarks on the subject?

E. A. Sperry (Sperry Development Company): I want to bring the greetings of the Society of Mechanical Engineers of which I am president this year. I am glad to say a word about the car that this committee has helped us to develop, and all the credit is due to them.

There is one quite wonderfully encouraging thing about the way we handle the car. We would not have the record at all if the current were not in the rail, and we put such a large current through the rail that it scares out every skeleton in its closet.

If that current is not in the rail, of course, we cannot find what is inside. But, unfortunately, if the current should fail in any way, two things would happen immediately. First, we would not get the record that we get at every rail joint and secondly, if the current should be present at both rail joints and suffer an eclipse somewhere along the length of the rail, an indication comes through on the record big enough to call out the fire department.

I am proud to have collaborated with the committee, and am glad if we have made a contribution. In the records this year we had a most able paper by Mr. Cushing, on the genesis of transverse fissures. It may be that the time has not come when we can write the next chapter on the exodus of the fissure, but here are the people who will do it.

Chairman Stimson: I should like to call upon Mr. Hughes of the Rock Island, since the detector car owned by the association probably had its most successful and spectacular trip on his road.

L. J. F. Hughes (C. R. I. & P.): When we found that we were going to get the detector car, we selected the piece of track where we had been having the most trouble with transverse fissures. This was 92 miles of rail which was rolled in 1913 and laid on our line which runs west from Memphis. Of that 92 miles of rail, up to December 20, when we began to use the detector car, we had had a total of 110 transverse fissure failures. These failures occurred in 41 heats, and of the 41 heats we had removed 17 from the track because of having 3 or more transverse fissure failures in the heats.

This track was on a comparatively light-traffic line. The tonnage passing over it during 1928 was 5,493,000 gross ton miles, and the heaviest locomotive used was a Consolidation type of about 100 tons. Thus we had an abnormal number of transverse fissures for comparatively light traffic, so the results that we obtained were most interesting.

Before starting out with the car we determined upon a method of procedure whereby we could keep an accurate record of the results and have our records so that we could refer back at any time and locate any rail on the record as secured.

We then decided that we would use a methodical way of examining the indications. We had decided that a three-point indication would surely be evidence of a transverse fissure, and while that decision was somewhat erroneous, on the first trip we examined only those indications which were recorded on all three points.

Our method of procedure was this: We started the car moving at 6 miles per hour and on the first three-point indication we would stop the car and go back and look at the rail. If there were no evidences of anything on the surface, we made a repeat on that same place. If the indication came through the second time we then made the check with the hand galvanometer.

Proceeding in this way we made our first trip over the 92 miles and as a result of that first trip we removed a total of 38 rails, of which 18 rails were moved because of visible defects. These 18 defects were picked up and recorded accurately. We removed 11 rails from track where we thought we had an indication of a transverse fissure and where we got some indication with the hand galvanometer, but we broke those rails and failed to find anything. Then we removed and broke rails and positively located transverse fissures.

After this trip it was decided to put on a device that would apply pressure to the current brushes. Air cylinders were applied, and we again ran the car over the same territory.

Before we had completed the application of the air devices, we received word that in the first trip we had passed up two transverse fissures, and the rails broke in track after the machine had gone over.

Checking our records, we found that both of those failures were indicated by the machine, but we who examined the record made the mistake by calling the indication a burn spot instead of a transverse fissure. Great care must be taken in making sure that the indication you get comes from the burn and not from a transverse fissure.

Being warned by the two fissures which we passed up, we were very careful on the second trip. On this second trip we removed a total of 26 rails, of which 5 were taken out on account of pits and visible defects; 10 were taken out as giving indications of a fissure and when we broke them we couldn't find anything; 11 were removed and disclosed transverse fissures.

After this we took the machine to our Kansas division and went over 100 miles of territory there, so altogether we have made with the machine a total of 287 miles. This 287 miles was covered in 18 working days, and our average mileage per day was 16 miles.

It cost us altogether, to run the car, $5,192. This figures at $18 per mile. The cost per day amounts to about $288. Of course, we used the work train all the time. We had a car of rail along and whenever we wanted to take a rail out we took it out.

[Mr. Hughes then called attention to two or three specific cases of rails renewed and continued.]

Mr. Hughes: I mention these cases to bring out how careful we must be in analyzing what we find on the tape. Another thing that I think is of quite great importance is the fact that we can locate visible defects, pipes, with that machine. It seems to me that some advantage can be taken of this machine in the inspection of rail in the mills. We know that it can locate piped rails in track, and we know that these pipes are in the rails when they come from the mills.

President Faucette: We would be very glad to have Mr. James E. Howard (I. C. C. Bureau of Safety) make some observations.

Mr. Howard: This is a Jeremiad. I have tried other means of persuasion. A serious accident occurred in 1911, caused by a broken rail of a type which I recognized as due to a component which had not previously been getting consideration, namely, the state of internal strain caused by the cold rolling action of the wheels on the running surface of the head.

A definite terminology was needed to signalize this type of fracture, and the term transverse fissure was applied to it. It was not a simple case of bending, since the most remote fissure was from the neutral axis, and as a rule the most strained ones were not those which were ruptured. It was at once evident that the cold rolling strains with compression in the top of the head of the rail were responsible for this type of fracture, a tension fracture in the interior. To me this seemed so self-evident that to mention it was considered quite sufficient. Why one rail was stronger than another was not part of the question. The fracture was of interior origin because the strains of tension were greatest at the interior of the head. That is in explanation of the transverse fissure.

This explanation did not meet with general acceptance. In fact, it didn't meet with any, at least for a time, and doubts were expressed whether fractures were ever formed in any such manner. Between twenty and thirty thousand transverse fissures, however, have removed all doubts on the subject, aided by 17 years to think it over. In the meantime many fantastic reasons were offered, more than a score of them, for the display of transverse fissures, by those who are not prepared to accept the real cause.

Coming down to the present time, is there any chemical proposition or treatment or weight of rail that will endure track conditions without the formation of transverse fissures, and what is going to be done about those rails which are now in the track, and which are annually displaying transverse fissures by the thousands?

Two accidents due to that type of fracture have cost over a million dollars. It is time for energetic action to be taken; taking out rails of one heat and putting in those of another does not lead anywhere. By no means, would it be difficult to settle some of the points of contention, whenever there is disposition to do so.

In regard to a couple of photographs which I have, one of these photographs illustrates a transverse fissure in a rail which caused an accident in the state of Kansas not long ago; the other photograph shows the two ends brought together. This photograph shows the transverse fissure which was located in Mr. Sperry's laboratory. A paint mark was made. The transverse fissure was in the exact center of that white paint mark.

I brought the transverse fissure to the surface by peening with a light hand hammer, and after 100 or 200 blows the crack reached the surface and showed its appearance half way across the top of the head and down on the gage side. I knew what could be done. I knew a hand hammer would bring that to the surface because I had done it before on split head rail, but that was an accelerated rate of formation and the disparity between a light hand hammer and a locomotive is such that I think you will realize the chances for a locomotive to do what I did.

Chairman Stimson: The statistics on rail failures are given in Appendix B, and we will pass them without presentation. The next subject on the Cause and Prevention of Rail Batter will be presented by Mr. Hunter McDonald (N. C. & St. L.), in the absence of W. J. Backes (B. & M.), the chairman.

Mr. McDonald: I am familiar only with that part of the report that I have contributed and E. W. Backes, who has been serving with W. J. Backes on this committee as an observer, will follow me and after outlining some of the work that he has had special charge of, will introduce a proposed addition to the Manual to cover a new method of making observations for the purpose of gathering statistics.

In regard to the work that I have particular charge of, under the head of "Lubrication," I have reached the conclusion from my own observations, that there is no use experimenting any further with oils and greases. In the same paragraph I refer to the possibilities of lubrication which may be found in the spraying of the ends of the rail behind the joint bar with a "Metalayer" process.

In the matter of sawing off the end overflow to prevent chipping, I correspond with a good many, but I haven't received any answers or any definite information. I feel, therefore, that that subject might well be dropped until some one is ready to report his experience on it.

We are still pursuing the plan of sawing after welding in order to eliminate all metal that adheres to the ends at the joint gap and thereby not interfere with expansion and contraction. We believe that is a better plan than to depend on the cold chisel in chipping it off.

[E. W. Backes (B. & M.) then submitted the proposed changes in the Manual covering the definition of batter and after suitable explanation the motion of Mr. McDonald that it be adopted was carried. Following this, A. F. Blaess (I. C.) presented the report on Economic Value of Different Sizes of Rail, and E. E. Adams (U. P.) presented the report on the reconditioning of battered or worn rail ends, the first being received as information and the latter for acceptance and printing in the Manual. The committee was then dismissed with thanks.]

Report on the Economics of Railway Labor

Committee gives attention to labor-saving equipment, force distribution, supervision and training of men

A. N. Reece
Chairman

THE following subjects were reported upon by the committee:

(1) Revision of the Manual.

(2) Methods for securing greater efficiency and economy in the use of labor-saving devices in railway track maintenance (Appendix A).

(3) Standardization of parts and accessories for railway maintenance motor cars (Appendix B).

(4) Equating track values for labor distribution (Appendix C).

(5) The economic ratio of supervision to labor (Appendix D).

(6) Practical training and education of the individual workman in his assigned duties, as a means for securing an increased output and better quality of work, with less effort and fewer accidents (Appendix E).

The committee recommended that Appendices A and D be received as information and the subjects be dropped; that Appendix E be received as information and the subject continued; that conclusion No. 1 in Appendix C be approved for publication in the Manual and the subject be closed; and that the subject of Appendix B be continued. No revisions in the Manual were recommended.

Appendix A—The Use of Labor-Saving Devices in Track Maintenance

A review of the cost of performing work with various labor-saving devices shows a considerable fluctuation in the unit cost of material handled or operation performed. These comparisons indicate the need of a satisfactory method of measuring and recording results obtained on different roads. However, there seems little doubt that the real cause of the difference in cost is due to one or more of the following conditions:

(1) The different conditions under which the operation is performed, frequency of interruption, and restrictions imposed by traffic.

(2) Character of material handled.

(3) Capacity and condition of the machine performing the work.

During the past year investigation was made of methods for securing greater efficiency and economy by the use of the following labor-saving devices:

(1) Rail laying machines.

(2) Rail oiling devices (for preventing corrosion).

(3) The advantages of operating in pairs or in multiple units, machines such as ditchers, rail loaders, ballast cleaners, etc.

(4) Labor-savings devices operated off track. Among the devices to be considered under this classification are

Caterpillar cranes and shovels,
Motor trucks and motor truck cranes for handling material in congested yards,
Paint sprayers,
Post hole diggers.

In order to illustrate the economical advantages of these mechanical aids, the committee included in its report a number of examples of methods and costs of operation of machines now in use. These examples, which space does not permit reprinting here, present a synopsis of the practices, opinions and conclusions of railway maintenance engineers in the United States and Canada, and from them the following observations were made:

General Observations

(1) To effect maximum economy, machines must be kept at work.

(2) To accomplish this, local supervisory officers responsible for their operation must be impressed with the fact that interest on the investment accumulates continuously.

(3) Adequate maintenance is important. Maintenance of way department shops, manned by experienced mechanics, are recommended where the amount and character of work justifies.

(4) To obtain maximum efficiency with labor-saving appliances, the employment and training of foremen and operators is becoming increasingly important. These men must possess mechanical sense and be free from prejudice against such devices.

(5) Each operation should be studied to determine the number and type of machines required to obtain the best results. This requires the co-ordination of thought and effort of management and the men in the field.

(6) Avoid mechanical saturation.

Conclusions

During the past four years, the committee has assembled information covering some sixty labor-saving machines and devices in general use at the present time. From this information the following conclusions are drawn:

(1) That labor-saving machines and devices carefully selected, efficiently manned, properly supervised and maintained, are productive of substantial economies in maintenance of way operations, and their use is recommended.

(2) Their economy is determined by comparison of the costs of the labor-saving operation with other methods or practices. It should be emphasized that savings effected on one railroad cannot consistently be compared with results on another road, or even upon one division, because of the many variables, such as traffic density, methods of operation, and other conditions which must be considered.

Appendix B—Standardization of Parts and Accessories for Motor Cars

Under the subject of rules for the care of motor cars, the committee stated that a conference was held during the year with a representative of the Committee on Rules and Organization, and an agreement reached whereby "Rules for the Care of Motor Cars," proposed by the committee and published in the Proceedings (Vol. 28, pages 297 and 298), together with an additional rule, would be substituted for the rules proposed by the Committee on Rules and Organization, outlining "Duties of Motor Car Operators." It was agreed, further, that the classification "Motor Car Operator" should be changed to "Motor Car Repairmen," as more descriptive of the duties of this position; and that due to the comparatively few employees coming within the scope of this classification, special rules for their guidance are unnecessary.

Under the subject of standardization of parts and accessories for railway motor cars, the committee reported that with the assistance of a committee composed of railway maintenance motor car supervisors, is still working with the motor car manufacturers' representatives on the standardization of parts and accessories for railway maintenance motor cars, and

although considerable information has been developed, it is not felt that sufficient research work has been conducted to permit making definite recommendations to the association.

Appendix C—Equating Track Values for Labor Distribution

Replies to inquiries addressed to a large number of railroads during the past two years indicate that about half of the railroads in this country have adopted the practice of equating track values, using all or a part of the list of comparative values or equivalents suggested in our 1922 report. The following items are most commonly used:

One mile of first main track is equivalent to:
1.15 miles of second main track,
1.33 miles of third or fourth main track,
2.00 miles of branch line track,
2.00 miles of passing and thoroughfare track,
3.33 miles of yard tracks,
12 main track switches,
20 side track switches.

Some of the carriers include other items, such as railroad crossings, city street crossings, county road crossings, track pans, ditches, fences, etc., but it is thought that the items tabulated above are sufficient for all practical purposes in equating the physical property to equivalent main line miles and that additional equivalents made necessary by local conditions should be established by individual lines.

The committee appreciates that in addition to a summation of equated mileage found on the several divisions of a railroad, consideration must be given, in distributing labor, to the comparative present condition of each division, the condition to be ultimately attained, comparative volume of traffic, difference in climatic conditions, grades, curvature, drainage, and other features that would have a bearing on the amount of track labor required.

An investigation was undertaken to determine the amount of track labor employed in roadway maintenance on railroads in the United States, based on annual reports of the Interstate Commerce Commission on statistics of railways, for the four years, 1923 to 1926, inclusive. From these statistics we have secured approximately accurate total of mileage, gross ton miles, and man-hours of track labor, by districts; converting the operated mileage and other property to a reasonably correct estimation of equated mileage, by using the equivalents hereinbefore referred to. The item of track labor was separated as between the accounts roadway maintenance, and track laying and surfacing, and further divided as between that "affected by use" and "not affected by use," in accordance with the recommendations of the Committee on Economics of Railway Operation (Vol. 24, page 1058).

Following a tabulation of the results of its investigation, the committee stated that an analysis of the figures compiled indicates that:

(a) Approximately 43 per cent more track labor "not affected by use" was worked per equated mile in the Eastern district, and 50 per cent more in the Southern, than was worked in the Western district.

(b) Track labor "affected by use," per million gross ton miles, was 14 per cent more in the Southern, and 21 per cent more in the Western, than was worked in the Eastern district.

(c) Upon converting man-hours to men (including foremen) worked per working day per equated mile, it was found that the amount of labor worked, both as "affected by use" and "not affected by use," was approximately 50 per cent more in the Eastern than in the Western district.

(d) If the traffic density in the Western and Southern districts were increased to equal that of the Eastern district, the average number of men (including foremen) per working day per equated mile would be increased to the extent that it would equal that of the Eastern district.

Conclusion

For equating the physical property of a road to equivalent main line miles, the committee recommended the following:

One mile of first main track is equivalent to:
1.15 miles of second main track,
1.33 miles of third or fourth main track,
2.00 miles of branch line track,
2.00 miles of passing and thoroughfare track,
3.33 miles of yard tracks,
12 main track switches,
20 side track switches.

To this list there may be added such other items as may be required, and the equivalents as so determined should be factors relating to present condition, traffic density, speed of trains, seasonal or climatic conditions, grades, curvature, drainage, and the ultimate standard of maintenance desired.

Appendix D—Economic Ratio of Supervision to Labor

The committee assembled data from representative roads throughout this country and Canada, with an aggregate track mileage of 112,035, regarding their maintenance of way employees, divided between supervision and labor. This includes the mileage of branch lines, side and yard tracks, etc. This mileage was reduced to total equated mileage, based upon the A. R. E. A. formula, resulting in an aggregate total of 159,464 equated miles.

All of the data compiled by the committee was tabulated and presented as an addenda to the report. Reviewing its data, the committee made the following comments:

On many roads, for years back, six miles of main track has been considered a reasonable length for a track section, especially before the general use of section motor cars. It is interesting to note that the average section length on the railroads reporting is six miles, equated to include branch lines, side tracks, etc. Of course, it must be admitted that the length of sections varies with the traffic and importance of the division, and it undoubtedly varies on different parts of the same road. However, six miles is a general average for the whole.

A track supervisor is responsible for the maintenance of an average of 121 equated miles of track, and for the supervision of 18 section gangs (ranging from a maximum of 54 to a minimum of 4 gangs). The average section gang consists of 4 men, resulting in an average section force per track supervisor of 103 men. In addition, the average track supervisor has 1.4 extra gangs of 19 men, making a total average force per supervisor of 19 foremen and 122 men. This does not, of course, include the supervision of work-trains and other special work.

A bridge and building supervisor (or master carpenter) has supervision over an average of 8 bridge and building, painter and water service foremen (ranging from a maximum of 36 to a minimum of one foreman), and for a total average force of 70 foremen and employees (ranging from a maximum of 307 to a minimum of 5 foremen and employees.)

In summarizing its findings, the committee said:

Personnel of Committee on Economics of Railway Labor

A. N. Reece, ch. engr., K. C. S., Kansas City, Mo.
Chairman
H. J. Armstrong, ch. engr., M. & N. A., Harrison, Ark.
C. A. Ashbaugh, asst. engr., G. C. & S. F., Galveston, Texas.
T. S. Bond, asst. ch. engr., I.-G. N., Palestine, Texas.
A. E. Botts, div. engr., C. & O., Huntington, W. Va.
W. S. Burnett, ch. engr. of const., C. C. C. & St. L., Cincinnati, Ohio.
Wm. Carpenter, supvr., B. & O., Garrett, Ind.
H. A. Cassil, ch. engr., P. M., Detroit, Mich.
H. M. Church, div. engr., C. & O., Hinton, W. Va.
C. C. Cook, maint. engr., B. & O., Baltimore, Md.
J. B. Dobson, asst. engr., B. & O., Baltimore, Md.
F. B. Doolittle, supvr. of str., N. Y. C., New York
John Evans, div. engr., M. C., Detroit, Mich.

F. M. Thomson, dist. engr., M.-K.-T., Denison, Texas.
Vice-chairman
J. A. Heaman, ch. engr., G. T. W., Detroit, Mich.
C. H. R. Howe, cost engr., C. & O., Richmond, Va.
E. T. Howson, western editor, Railway Age, Chicago.
C. S. Joseph, asst. engr., A. & W. P., Atlanta, Ga.
J. B. Babile, supvr. work equip., C. R. I. & P., Chicago.
F. J. Meyer, asst. engr. m. w., N. Y. O. & W., Middletown, N. Y.
G. M. O'Rourke, rdmst., I. C., Carbondale, Ill.
J. C. Patterson, ch. engr., m. w., Erie, New York.
F. S. Schwinn, asst. ch. engr., I.-G. N., Houston, Texas.
H. M. Stout, record engr., N. P., St. Paul, Minn.
G. M. Strachan, asst. engr., A. T. & S. F., Chicago.
W. M. Vance, asst. engr. m. w., M. P., St. Louis, Mo.
Cale Wamsley, sr. asst. engr., M. P., St. Louis, Mo.

The organizations, as reflected by addenda to this report, have been built up through many years of experience and in many instances were originally worked out in their present form when traffic was much lighter, speed slower, standards of maintenance less exacting, weight of equipment much less, and practically all maintenance of way work was performed by manual labor. With the reverse of these conditions and the use of labor-saving devices, which requires added supervision, and the varying conditions on different roads, it would be extremely difficult to establish a definite relation between supervision and labor that would be applicable to all railroads.

It is the conclusion of the committee that the ratio of supervision to labor is an individual problem for each railroad, and that the data in this report be applied by making suitable equations for individual lines by those most familiar with their own requirements.

Appendix E—Practical Education and Training of the Workman in His Assigned Duties

Following are abstracts from the report of the committee, which dealt with the education and training of workmen primarily as a means of securing an increased output and a better quality of work, with less effort and fewer accidents:

The accident prevention feature of this subject is exceptionally well covered on nearly all American railroads. It appears that all practical means are provided to safeguard maintenance of way employees in the conduct of their work. Safety appliances are provided on machines used by maintenance of way employees; tools are carefully inspected by foremen, to prevent injuries from flying particles of steel; goggles are worn by employees when any work is undertaken where material is likely to fly, thus protecting their eyes; and foremen are constantly on the alert to see that men do not engage in any practice in performing their work in a manner that might cause injury to themselves or their fellow workmen.

On most railroads, monthly or other periodic meetings are held on each division or other operating unit, which are attended by foremen, supervisory officers and other officials. These meetings are conducted solely for the purpose of promoting safety in all departments of railroad work.

Among the earliest discourse of industrial safety, we find the statement: "A safe plant is an efficient plant." This thought has been expressed so repeatedly that it has become the working creed of safety experts. This principle applies equally as well to the scattered organization of a railroad maintenance of way department as to the condensed and closely supervised departments of an industrial plant.

Most accidents are the result of contributing causes, not the least of which concern the personal element, such as lack of skill, inattention, improper supervision, fatigue, defective vision, and many others that affect both safety and productive efficiency. If any of these causes are eliminated, efficiency is thereby improved.

We do not find, however, the well developed organization for training and education of the individual workman in his assigned duties as is found in our accident prevention department. In fact, there is little, if any, provision for the instruction of the novice in maintenance of way work, other than that imparted to him by his foreman.

Some railroads have schools for the education of workmen who desire to become foremen, or from whom it is expected that foremen will be made. However, the schools themselves are not ordinarily under the same supervision and, therefore, the foremen turned out in this manner probably have different ideas as to the method of performing their work.

The Chesapeake & Ohio, as well as the St. Louis-San Francisco, has gone very far into the study of methods of performing maintenance of way work, with a view toward securing detailed information and cost analysis on methods of performance, and should, with this intensive study, through close observation, develop some very useful and interesting data.

A general practice in breaking in a new man is to pair him with an experienced workman, where his pride is more or less tested, in order to adapt himself to his new work and keep up with his partner.

On a number of lines, considerable attention is given to the program of maintenance work, to keep a uniform force employed and to avoid the general use of extra gangs. In some instances, education is confined to more hygienic lines, involving better housing and living conditions, with baths of hot and cold water, beautification and landscaping the surroundings, as well as other conveniences for the laborers and their families, in an effort to stimulate self-confidence and keep a better satisfied personnel, with ambition to remain in the service.

On many railroads, in the bridge and building and related departments, the training for increased output and better work on the part of laborers and mechanics is followed quite closely, and the results are indicated in periodical reports of work performed by the various gangs. These reports are used as a means for comparing the relative output of one gang with another.

It is also the custom on many railroads to have foremen's meetings where maintenance of way work is discussed for education in practical application of methods of performing work; adhering to standards; and a study of all problems confronting the track foreman.

A number of railroads follow a general apprentice system in the signal department, whereby the workman starts in at a low rate of pay and is automatically stepped-up in pay each six months or each year for a period of approximately four years. Under this system, ordinarily, men are employed as helpers and promoted to assistant signalmen, and from assistant signalmen to signalmen or maintainers, after serving their full apprenticeship.

There is a large field to be covered for special training of maintenance of way employees, particularly in the track department, and it should be the duty of every maintenance organization to study the best methods of performing each item of work, with a view toward securing the best practices, and have these standardized. The foreman must be taught the safe and efficient methods of performing his work. Due to isolation from close contact with his superiors, the foreman must constantly act on his own initiative. Therefore, it is extremely important that he is not too greatly handicapped with hard and set rules governing the performance of his work.

In summarizing its findings, the committee stated:

We feel that a great improvement is badly needed and can be made in the instruction of embryo mechanics in the maintenance of way department. It is our thought that an efficient track employee is a tradesman, experienced in the use of a large variety of tools and trained in placing various kinds of material, under changing conditions of traffic, foundation and climate. A track laborer should have at least two years' experience to become proficient in this kind of work, and to acquire proficiency in this length of time he must have exceptional opportunities and be unusually apt and willing to learn.

This subject is of such general nature that the committee does not consider it advisable to make definite recommendations for standard methods of performing each item of maintenance of way work.

Discussion

[The report was presented by Chairman A. N. Reece (K. C. S.), who stated that the committee had nothing to offer on the revision of the Manual, and then asked F. M. Thomson (M.-K.-T.), the subcommittee chairman, to submit the matter in Appendix A. This was received as information. Chairman Reece then introduced F. S. Schwinn (M. P.), chairman of the subcommittee on Equating Track Values for Labor Distribution, who read a large part of the material in Appendix C *and moved that the conclusions recommended for publication in the Manual be accepted.*]

J. E. Willoughby (A. C. L.): I trust that the committee will not insist that this table, as it has given it, be inserted as recommended practice. The table as indicated from the text preceding is an average of the United States, and as information is extremely valuable, but for a man to say that one mile of first main track is equivalent to two miles of branch line track without further information is nonsense.

President Faucette: I understand Mr. Willoughby's objection to this report is, he is not willing to see this table go in unless it is accompanied by an explanation in the Manual. As an isolated report, Mr. Willoughby is not in accord with that plan.

C. W. Baldridge (A. T. & S. F.): I had much the same thought that Mr. Willoughby had, except that I want to go much further. I do not believe this should go in the Manual.

C. C. Cook (B. & O.): Perhaps I can clear it by stating that it is already in the Manual. It was approved in connection with the report on standard

methods for performing maintenance of way work for the purpose of establishing units of measure of work performed. That was, I think, in the year 1923.

President Faucette: As it now stands, it appears in the Manual. The chairman of the committee says the reason for asking this is so that it may reappear in connection with his report.

Mr. Baldridge: We have been making considerable effort for the last three or four years to reduce matter in the Manual to keep it within reasonable size, and if this matter is already in the Manual I see no reason for putting it there again.

Chairman Reece: I am willing to eliminate the recommendation for publication in the Manual and submit it for information only.

[*The president then withdrew the call for a vote on the motion.*]

V. R. Walling (C. & W. I.): These units as far as they go are very valuable information. For terminal railroads it would be of very great assistance and help if the committee could carry forward its investigation to include such important items as railroad crossings and slip switches. For my part, I should very much dislike to see this subject closed without their making an investigation, and submitting to the convention later their recommendations for those important items.

President Faucette: I shall ask the Committee on Outline of Work to take these recommendations under consideration.

[H. A. Cassil (P. M.), chairman of the Subcommittee on Economic Supervision of Labor, then submitted the matter in Appendix D as information and it was so accepted. The same action was taken on Appendix E, submitted by Lem Adams (U. P.), after which the committee was excused with the thanks of the association.]

Closing Business

IN closing the business of the association President Faucette announced that the attendance had broken all records with a registration of 1,001 members and 402 guests or a combined total of 1,043. This was followed by the presentation of a medallion to Past-President J. L. Campbell, as reported elsewhere in this issue, and by various resolutions of appreciation and thanks for service given by members, speakers, press, etc., and by the announcement of a 624 to 50 vote in favor of an amendment to the constitution broadening somewhat the rules governing the qualifications for active membership. The association then proceeded with the induction of President-elect Louis Yager, who was escorted to the platform by Past-President D. J. Brumley (I. C.) and Earl Stimson (B. & O.), where the retiring president, W. D. Faucette, spoke in part as follows:

"It is a pleasant duty and a proper act on my part to pass to you the duties of president. In doing so I want to say that you are honored by an association unequalled in this world. You have shown yourself capable of these responsibilities; you have the proper equipment; and you are one on whom your fellow members have placed willingly and gladly the duties of that great office."

The response of President Yager was in part as follows:

"My membership in this association is in no respect different from that of all the others. It has been a continuing opportunity for professional development and a privilege of contributing service to the general welfare. As the character of a man may be suggested by the company he prefers, so the success of an executive is indicated by the type of officers with whom he is surrounded. You have selected the official family, of whom I am one. In recognition of the confidence expressed in your selection, we pledge to you our best best efforts in the fulfillment of our obligations. I know that you will extend to us the same generous support and cooperation which you have given to our predecessors. Through your sustained interest in the work and the solicitude for the welfare of the association, we will be able to maintain the high standard of service and professional ideals which have characterized our association's activities."

The thirtieth annual convention of the A. R. E. A. was then adjourned.

A. R. E. A. Registration

A TOTAL of 51 members and 47 guests registered yesterday, bringing the total registration for the convention to 1,001 members and 402 guests, a combined total of 1,403. This compares with a total registration last year of 968 members and 348 guests or a combined total of 1,316 and of 925 members and 346 guests, or a total of 1,271 in 1927. This is the first year in the history of the association in which the registration of members has exceeded 1,000 and the total registration 1,400. The names of those who registered yesterday follow:

Alphabetical List of Members

A

Ackerman, C. E., Jr., office engr., A. C. & Y., Akron, O.
Adamson, J. H., asst. engr., B. & O., Baltimore, Md.
Atwill, William, gen. mgr., I. C., Chicago.

B

Beach, Dr. S. C., Chicago.
Beach, M. W., asst. dis. engr., N. P., St. Paul, Minn.
Blaine, M., A. R. E. A., Chicago.
Bowman, D. C., engr. and contr., St. Louis, Mo.
Brown, P. M., engr.-acct., M. P., St. Louis, Mo.
Brunner, John, mgr. dept. of metlgy., Illinois Steel Co., Chicago.

C

Carpenter, William, supvr., B. & O., Garrett, Ind.
Conatser, S. F., asst. engr., I. C., Carbondale, Ill.
Condron, T. L., con. engr., Chicago.
Cox, J. B., con. engr., Chicago.
Crowder, A. F., asst. engr., M. P., St. Louis, Mo.

D

Dalstrom, O. F., engr. of br., C. & N. W., Chicago.
Donovan, J. F., div. engr., L. V., Easton, Pa.

E

Edgerton, H. H., engr. sur., C. G. W., Chicago.

F

Fabry, L. F., asst. engr., I. T., St. Louis, Mo.

G

Gehrke, Edward, asst. to asst. sec., A. R. E. A., Chicago.
Gilley, J. G., asst. div. engr., C. & O., Ashland, Ky.
Gilstorf, H. K., tr. supvr., P. M., Detroit, Mich.
Glass, R. G., mgr., bur. of inves., Illinois Steel Co., Chicago.
Griswold, E., A. T. & S. F., Chicago.

H

Hammond, E. W., engr. m. w., B. R. & P., Rochester, N. Y.
Hunley, J. B., engr. br. & struc., C. C. C. & St. L., Cincinnati, O.

J

Jabinsky, Louis, asst. engr., C. C. C. & St. L., Indianapolis, Ind.
Johnson, J. M., con. engr., I. C., Louisville, Ky.

K

Kenly, R. G., asst. to pres. and chf. engr., M. & St. L., Minneapolis, Minn.
Kenney, E. F., metl. engr., Bethlehem Steel Co., Bethlehem, Pa.
Kennon, W. A., div. engr., M. P., St. Louis, Mo.
Kleeberg, E. F., asst. engr., I. C., Chicago.

L

Larkin, M., I. C., Chicago.
Libby, Paul, asst. engr. br. dept., M. P., St. Louis, Mo.
Lumpkin, Roy, ch. clk. engr. m. w., C. R. I. & P., Des Moines, Ia.

M

McDougall, N. R., ch. clk., C. & W. I., Chicago.
McDonald, W. F., div. engr., C. M. St. P. & P., Spokane, Wash.
McGee, W. A., mech. engr., N. Y. C., Cleveland, O.
McNellis, Frank, asst. sec., A. R. E. A., Chicago.
Miller, A. A., engr. m. of w., M. P., St. Louis, Mo.

N

Neff, F. H., prof. of civil engr., Case School of Applied Science, Cleveland, O.
Nelson, N. P., div. engr., C. B. & Q., Casper, Wyo.
Nestile, A. C., Holden Co., Ltd., Montreal, Que., Can.
Novak, Joseph, Jr., engr.-acct., M. P., St. Louis, Mo.

P

Paris, C. H., chf. engr., C. & I. M., Springfield, Ill.
Pariseau, J. N., chf. draftsman, N. P., St. Paul, Minn.
Patterson, E. F., asst. engr., Wabash, St. Louis, Mo.

R

Rudd, James, metallurgist, test dept., C. R. I. & P., Chicago.

S

Sample, C. S., res. engr., N. Y. C., Newark, N. J.
Schnebelen, J. J., asst. engr., M. P., St. Louis, Mo.
Schwendt, B. J., asst. sig. engr., N. Y. C., Cleveland, O.
Scott, H. E., con. engr., Industrial Track Construction Co., St. Louis, Mo.
Sheldon, C. S., engr. br. and struc., P. M., Detroit, Mich.
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Fritch, Francis, Chicago.
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Larsen, Albert, Milwaukee, Wis.
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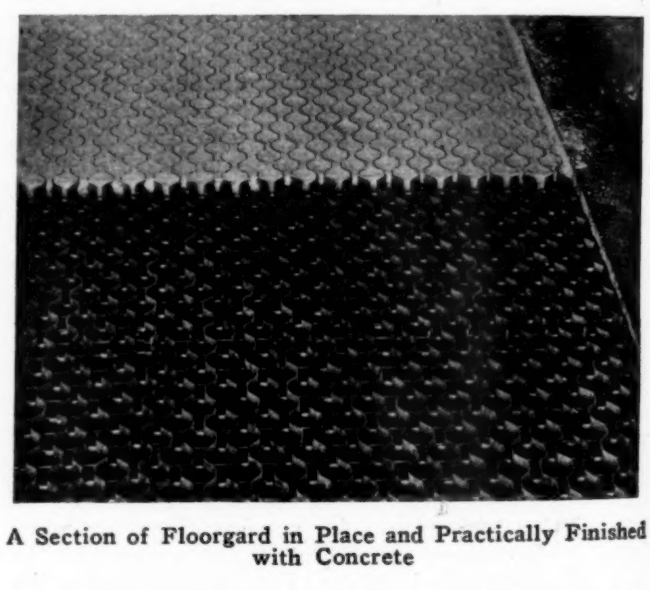
A New Armoring for Floors

THE Blaw-Knox Company, Pittsburgh, Pa., has put on the market a new steel armoring for concrete, asphalt and composition floors, which is said to add greatly to the strength of floors and to extend their useful life, with little or no maintenance. This new armoring, which is known as Floorgard, is, in reality, a built-up continuous steel mat, which is laid to form a wearing surface and reinforcing in the floor. It consists essentially of a number of specially formed steel strips, which, when placed together, form an open-work steel mat over the surface of the floor.

In placing the armoring, the steel strips are set on edge, and are joined by small circular tie rods, which are inserted in a horizontal position through holes in the strips. Lugs are provided on each strip, immediately adjacent to the tie-rod holes, to act as anchors for the plastic material used in the floor, and also to serve as separators between the strips. The strips can be spaced at various distances apart, as desired, making it possible to adapt the armoring to the particular requirements of any floor.



A Section of Floorgard in Place and Practically Finished with Concrete

Through the pattern adopted, which has been designed to provide great strength, and to distribute loads over a wide area, the concrete or other material used in the flooring is monolithic throughout, and no acute angles are formed in the flooring material, which might readily be broken off.

While Floorgard is adapted for use in entire floors, it is particularly suited for use in specific places where loads are the greatest or where traffic is the most severe. It can be cut readily in the field to suit any location, and is particularly effective for use in aisles or trucking-ways where there is a large amount

of wheeled traffic. It is said that Floorgard cannot be worn away by passing traffic, and that its particular design does not allow cracks to develop or spread, or corrugations to form in such soft materials as asphalt and special compositions.

The Blaw-Knox Company is also manufacturing a steel armoring, similar to Floorgard, which is known as Pavegard. This latter type of guard is of sturdier construction, and is designed specifically for strengthening the surfaces of roads, bridge decks, and other forms of pavement which are ordinarily subjected to extremely heavy wear.

Development of ZMA Process for Timber Preservation

TIMBER treated with ZMA or Zinc Meta-Arsenite, developed by the Curtin-Howe Corporation, New York, either by the Rueping or full-cell process, has been developed during the year to the point where it is now being used by the railways for bridges, station platforms, flooring, and to a small extent for ties, in addition to its employment for poles and crossarms.

The Rueping process is favored, since it keeps down the moisture content, thus effecting a considerable reduction in weight as compared with the full-cell process. The standard solution is 3 per cent, with an injection of one gallon per cubic foot, providing a final retention of ¼ lb. of dry ZMA to the cubic foot. When treating particularly dense timber, the usual preservative practice is to inject a greater amount of the preservative in order to secure sufficient penetration. With ZMA, it is possible to lower the concentration and to inject a greater quantity of the solution at no increased cost. For example, if a 3 per cent solution is used, one gallon per cubic foot is injected; with a 1 per cent solution, the injection is increased to three gallons per cubic foot in order to leave the same amount of dry ZMA in the wood. The treating operations are identical with those using other preservatives, thus involving no structural changes in plant for its use.

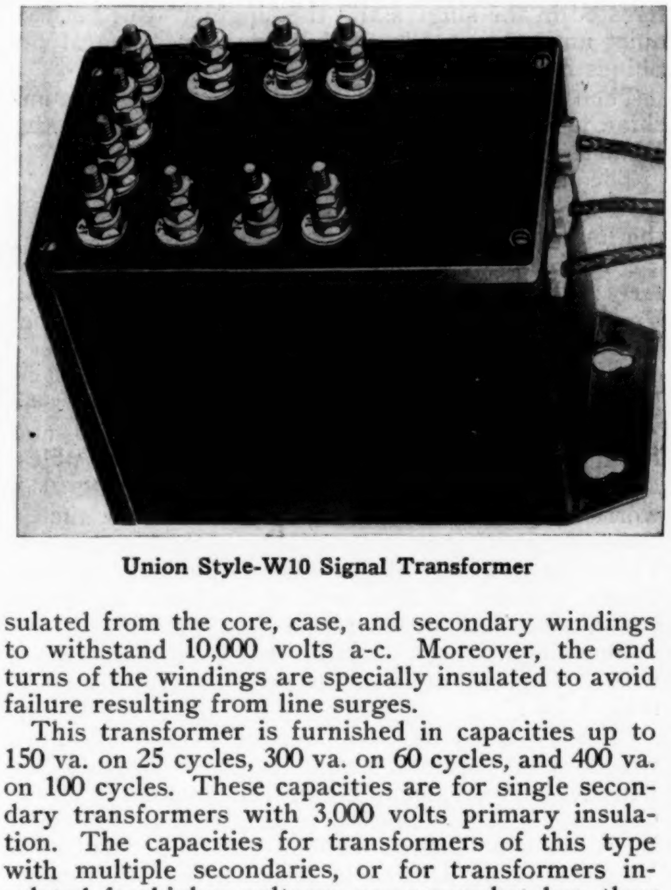
To date one railway and eight commercial wood-preserving companies have been licensed to use this process and all but two of these have commenced treatment with the ZMA preservative. The Chicago, Burlington & Quincy is treating all of its poles with ZMA at its Galesburg (Ill.) timber treating plant.

Union Type-W10 Transformer

A SIGNALING transformer, greatly improved mechanically and electrically, known as the Union Type-W 10 transformer, has been developed and placed on the market, by the Union Switch & Signal Company. It is recommended for all types of railway signal and rectifier service. The Type-W 10 transformer is of the completely enclosed type. The terminal board, carrying a maximum of 24 A. R. A. terminals, is of bakelite, and forms the top of the transformer. The terminal posts are nickel-plated to resist corrosion and each post is clearly and plainly marked. The case of the transformer is given a black crystalline finish which is resistant to mechanical injury and moisture. Mounting holes are provided to permit either shelf or wall mounting. The transformer is 9 in. long, 4⅝ in. wide, and 7½ in. high, over all.

The transformer core is of efficient design, resulting in a low "no-load" current. The coils are wound with fabric-covered wire and are insulated with the highest grade insulating materials. The entire core and coil are impregnated by the vacuum process to prevent the entrance of moisture.

The Union Type-W 10 transformer can be furnished for primary voltages up to 575 volts, and for any commercial frequency. On transformers where the primary voltage is below 220 volts, the primary terminals are connected to A. R. A. terminal posts on the bakelite terminal plate, and the primary is insulated from the core, case and secondaries to withstand a 3,000-volt ground test. Where the primary voltage is 220 volts or more, the primary terminals, which consist of flexible insulated leads, are brought out of the case through insulating bushings. In this way all high-potential connections are kept off of the terminal board. The primary in this instance is in-



Union Style-W10 Signal Transformer

sulated from the core, case, and secondary windings to withstand 10,000 volts a-c. Moreover, the end turns of the windings are specially insulated to avoid failure resulting from line surges.

This transformer is furnished in capacities up to 150 va. on 25 cycles, 300 va. on 60 cycles, and 400 va. on 100 cycles. These capacities are for single secondary transformers with 3,000 volts primary insulation. The capacities for transformers of this type with multiple secondaries, or for transformers insulated for higher voltages are somewhat less than those given.

Any combination of secondary windings and taps may be provided up to a maximum of 24 terminals. A durable tag is attached to each transformer, giving complete information concerning voltage and current ratings, and showing all voltages available. The Union Type-W 10 transformer is highly efficient, compact and meets all Signal Section, A. R. A., requirements for track, lighting or rectifier transformers.

J. C. Patterson, chief engineer maintenance of way of the Erie, is another member who left the charms of Havana for Chicago. Nobody would have been able to trace him down, but he played in a golf tournament and so got his name in the Cuban dispatches in the American papers. Which shows that one should not play golf well if one wishes to avoid publicity.

Little Rollo and His Pop

Chapter IV. Wherein the young man visits the annual banquet and, as usual, gorges himself with food, mental and otherwise

ROLLO was, for him, almost well-behaved at the banquet Wednesday night. Even though he is highly punctual where meals are concerned, and 6:30 means 6:30 to him, he made no complaint. It must be admitted that he gazed longingly at the oysters, while waiting for the occupants of the speakers' table to come up from the mysterious recesses downstairs. It must also be admitted that he managed to eat his own and his Pop's oysters, while the dignitaries were slowly filing in, but, beyond that, his conduct was exemplary.

Like certain other diners, he was very much interested in the singers and the singing. But he was quiet until they rendered the number: "The Moon Shines Bright Along the Wabash."

Then he burst forth: "Pop, doesn't the moon shine just as bright along the C. & A. as along the Wabash?"

The college songs intrigued him.

"Pop," he asked, "why do they only sing about the universities of Illinois and Wisconsin?"

Pop, being from Purdue, replied somewhat bitterly: "I don't know, my boy, unless it's because President Faucette graduated from North Carolina, Vice-President Yager from Minnesota, Vice-President Brooke from Virginia Military Institute, and Vice-President Baldwin from Lehigh."

The head-waiter came by looking worried and Rollo immediately asked him to explain his troubles.

"I'll tell you, boy," that dignitary explained, "I'm worried about the laundry bill. I never saw such a bunch for writing on table-clothes as these engineers. There are diagrams of locomotive terminals, passing tracks, wooden bridges and signal installations on every table-cloth in the place."

The singing began again, and Rollo interrupted with: "Pop, are most of the people at the speakers' table Irish?"

"I don't think so, son," replied Pop, "Bob Ford was born in Vermont, Frank Ringer in Kansas, Dan Brumley and Ed Lee in Ohio, Bill Faucette in North Carolina, Viscount Massey in England, Louis Yager in Wisconsin, George Brooke and Bill Seddon in Virginia, Larry Downs in Indiana, Sid Withington in Massachusetts, Milt Post in Connecticut and Jack Armstrong in Illinois."

"Well, then, why did they all sing 'My Wild Irish Rose' so very loudly and applaud so vigorously afterwards?"

"Probably because St. Patrick's Day is fast approaching, Rollo."

Rollo listened attentively when Mr. Cole began his speech. The activities of the attendants, who kept turning the lights on and off behind the speaker, intrigued him hugely.

"Why are they doing that, Pop?" he asked.

"I don't know," Pop replied, "unless in an endeavor to entertain the 'water-logged audience.'"

Rollo's bright eyes darted hither and yon among the assembled throng. Say what you like about the kid, he hardly ever misses anything worth seeing.

"Who are the men upstairs with the ladies?" he asked presently.

"Probably traffic men," replied Pop, with a most superior air.

When Viscount Massey rose to speak, Rollo could hardly contain himself.

"Hey, Pop," he yelled, "look, look, who are those men over there in the corner, weeping into their coffee?"

"That's H. R. Clarke, general inspector of permanent way of the Burlington, and a bunch of assistant engineers, maintenance of way and structures."

"But why are they crying, Pop?"

"It's just sheer envy, Rollo. They are sad because, until tonight, they thought that their titles were longer and had more letters in them than any titles in the world."

"And what made them change their minds?"

"Well, Rollo, just look at the speaker's title in the program: Envoy Extraordinary and Minister Plenipotentiary from Canada to the United States. No engineer, not even a superintendent of tie and timber treating plants, can ever hope to equal that in number of letters and general magnificence."

"Aw, the poor men," commented Rollo, sympathetically.

Rollo was a most busy youngster in the foyer after the banquet. So busy was he, in fact, that he literally ran around in circles. First, there was Mr. Faucette's brand new cup to examine, then he had to congratulate Messrs. Yager and Brooke and all of the new directors, individually and in groups. Pop was over in a corner, with a group of his cronies, discussing important affairs. Rollo came over presently.

"Hey, Pop, why are you standing here?"

"Don't bother us, Rollo, we are discussing important engineering problems."

"Humph," said Rollo, "then why are you standing right next to the door where the lady singers are coming down from upstairs?"

Pop made a pass at the youngster, who ducked with the skill acquired of long practice.

"All right for you," he yelled, as he raced for the elevators, "I'm going to tell Mom."

Silent At Last!